The City as Classroom:
A New Vision of Public Urban High Schools
For the Twenty-first Century

The Greater Philadelphia STEAM Initiative:

Phase 1 Report

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Preface

This Phase 1 report describes the first phase of a three phase effort to fundamentally rethink the purpose of public high schools in urban settings and to plan for the establishment of a new high school model that provides greater meaning and usefulness for students in the twenty-first century.

For the construction of this new vision, we draw upon data collected from 134 individuals representing 74 nonprofit, governmental and educational organizations, who participated in at least one in a series of eight design studios held between November 5, 2015 and November, 2016. This new vision is then placed in the context of the needs of Generation "Z" and the simmering college and career- readiness crisis for students from low to middle income households.

We describe previous efforts to reform high school education over the past twenty-five years as an earnest but flawed enterprise. We argue that articulating a core purpose to high school was a critical missing ingredient; that without a clear purpose to a high school education *as a value in its own right*, in addition to its value as preparation for further education, there is no rational means of creating an engaging, meaningful and coherent curriculum.

Using lessons learned from our experience designing scores of Science, Technology, Engineering and Mathematics (STEM) high schools in the United States, including most recently eleven STEM schools in Egypt, we detail a new way of conceiving urban high schools. This new design incorporates the artistic, cultural and historical resources of the city to create a completely new educational environment for students – *The City as Classroom* - one that brings renewed hope and a way forward for them.

This Phase 1 report sets forth this new vison in detail and describes other aspects of the curriculum design and pedagogical framework. We also detail various school operational, governance and financial considerations. We conclude with a description of steps and activities involved in Phase 2 and its approximate cost.

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Executive Summary

A New Approach to the Fundamental Purpose of High Schools

Imagine a high school as a place where learning is informed by regional business and industry clusters, designed by leading regional educators, integrated across disciplines, shared across grade levels and courses, supported by coordinated programs at leading museums and arts, cultural and scientific organizations, and reinforced by parents and community partners. Imagine high school students discovering the importance of physics by understanding how automobiles, airplanes and ships move, or understanding the history of our great city by exploring its unique geography, culture, and history and economic and political significance. By integrating arts and culture into a place-based integrated STEM curriculum, with connections to informal education resources in the city, high school as reconceived can be an expanded network of learning spaces where students gain better insight into themselves and their world to discover the future is theirs to create.

Our Concept

The City as Classroom STEAM High School's intent is to use the city as a means to incorporate informal learning opportunities with formal education using an integrated *Science, Technology, Engineering, Arts and Math (STEAM)* curriculum. The goals of the school are to: empower young people to find their sense of place in a diverse and united community; connect to the regional culture and economy; learn to navigate the complexity of the world around them; acquire a sense of direction and purpose; learn to learn both independently and collaboratively; think critically and solve problems; to create a sustainable life for themselves and their community; and act responsibly and respectfully toward themselves and others.

Rationale

Generation "Z," children born at the turn of the millennium will soon be graduating high school. Many face severe challenges: poverty, family dysfunction, violence, insecurity, social injustice, a rapidly changing economy, and more. These challenges are particularly acute in urban settings. On top of this, many, if not most young people are intensely focused on solving a fundamental problem – finding their sense of place and community in what seems like a chaotic and uncertain world. Young people live a world of constant distraction and instant gratification given ubiquitous and easily accessible social media, 24/7 news, streaming TV and infotainment, with TV reality shows and advertisements everywhere. They live in a postmodern world filled with sophisticated illusions, shallow appearances and fake news. What many young people seek is meaning and authenticity.

This generation needs to be able to think broader than their neighborhoods and individual concerns. They need to be prepared to thrive in a global economy that transcends national borders. They must understand how intimately the rest of the world is connected to the United States and to the Philadelphia region. The challenges that face the rest of the world face we face at home as well. Rising high school students need to be prepared for a world that is ever evolving. They must be ready to use their minds to meet challenges that have not even as yet emerged.

The City as Classroom STEAM High School is a new educational paradigm for comprehensive high school education, a paradigm that views children holistically living in a particular place, within a particular time, and within a particular community - one that encourages the development and education necessary to create a life that is worth living. We need to educate children by first understanding them and their generation. Only with this sympathetic understanding of growing children can we create a curriculum with a mutually reinforcing blend of informal and formal education that provides value to Philadelphia-area youth.

The Rethinking High Schools STEAM Initiative was launched in July 2015 with generous support from the Barra Foundation Catalyst Fund. This Phase 1 of *The City as Classroom STEAM High School* is the result of eight design studios involving approximately 134 people from 74 organizations conducted from November 2015 to November 2016.

This report is a work in progress. Thus far, we have completed the first four steps in an eighteen step design process. Yet these first four steps are foundational to all the rest. As we complete these other steps this report will be updated, refined and revised. As it now stands, this report contains the following:

- Sections I describes Generation Z and the unique condition of youth in the 21st century.
- Section II why the mantra of college and career success is inadequate for high school and the nearly two decades of previous work to rethink public high schools that have led up to the current initiative.
- Section III describes the beginning of the Rethinking High School /STEAM Initiative and the progress to date.
- Section IV describes the *City as Classroom* STEAM Integrated Curriculum Design Principles and the remaining work to be done to create a STEAM curriculum scope and sequence.
- Section V describes the *City as Classroom* STEAM pedagogical framework and principles.
- Section VI outlines the recruitment, selection, and evaluation of students and teachers.
- Section VII discusses the *City as Classroom* school governance, management, partners, and school finance.
- Section VIII. Future Tasks and Funding Needs

I. Introduction - Why change?

1. Generation Z - High school is very much a 20th century phenomena. Its purposes over the past century have been varied, contested, and often muddled, reflecting the many transformational advances in science and technology and profound changes in the social, religious, and political order. While it may seem a cliché to say that the education and social development of new generations of youth are fundamental to a nation's future prosperity and civility, this belief was not widely held at the beginning of the Republic. Indeed, publicly funded education did not gain a firm foothold in state constitutions until the mid-19th century. Even so, by 1870, the average education attainment of Whites was only 6th grade; for Blacks it was 1st grade (in antebellum slaveholding states, it was criminal to teach Negroes to read.)[1] [2] For the remainder of the 19th century, education attainment rose slowly. By 1900, high school enrollment was less than 10 percent of all children aged 14-17. And of those who attended high school, the average attendance was less than 100 days a year.[3]

All of this changed dramatically in the 20th century. The rise of the U.S. as a world industrial power drove the need for industrial education to be taught to students in a formal way as industrial apprenticeships proved inadequate. A 40 year effort to install industrial education in public schools finally culminated in the passage of the Smith-Hughes Vocational Education Act of 1917, only the third major federal involvement in education since 1790. As a result, high school vocational education enrollment exploded just in time to supply a pool of skilled industrial labor for the first half of the American 20th century including the World War II mobilization. At the same time, the surge in mid-level white and pink management and sales positions, as well as military manpower needs, in the 1940s and 50's required high school level English language literacy and basic business and computational skills. Throughout the 1950s, 60s and 70s, as college enrollments soared, preparation for college, along with a vague "fulfilling their human potential" rationale became another new purpose for high schools layered onto these early purposes.

Now that we are in the 21st century, what does it mean for a high school graduate to be truly educated? What do current and future students in the Greater Philadelphia region need to know to be productive citizens and live healthy and happy lives? Certainly children born at the turn of the millennium face many challenges: poverty, family dysfunction, violence, social injustice, job/career readiness and more. These challenges are particularly acute in urban settings. But these are not new challenges. Most all young people throughout the generations have had to grapple with these challenges, some more some less. Most all have had to resolve the deeply personal questions of: "Who am I, and where and to whom do I belong"?

Solving this fundamental problem of the self has never been is a simple matter. But in the 21st century, it has become immeasurably more complex for these post-Millennial, "Generation Z", or Plurals.[4] Generation Z, consisting of a quarter of the US population, are growing up in the era of the world-wide web. It is a world of constant and divergent distractions. Social media, such as Twitter, Facebook, and Instagram; web-streaming infotainment; TV reality shows; and advertising screens are everywhere. Electronics devices have converged to become ubiquitous occupying every crevice of life. Even automobiles have Wi-Fi. Generation Z is on the front lines of a new postmodern world, a world filled with sophisticated illusions, shallow appearances and fake news; a discordant cacophony vying for their attention, money and following. Disturbing images are a click away, ranging from hate filled propaganda and violent images to self-loaded exhibitionism and sex texts.

At the same time, wise and steady voices with the moral authority to lend personal support and guidance to developing children have weakened, if not become silenced altogether. Signs of this weakening abound. Nearly 40 percent of children today live with either a single parent or none at all compared to only 13 percent in 1960.[5] Trust in institutions that help shape young lives are at historic lows. In a 2016 Gallup survey, only 41 percent of respondents expressed "a great deal" or "quite a lot" of confidence in church or organized religion, down 11 percentage points from 2006.[6] Church attendance and religious affiliation continues to decline with nearly a quarter of those surveyed indicating no religious affiliation.[7] The rash of clerical pedophilia scandals and cover-ups have eroded traditional church-based moral authority. Confidence in secular institutions important to the guidance of young people is even lower: only 39 percent cite a great deal or quite a lot of confidence in the medical system; 36 percent in the Presidency and the U.S. Supreme Court; 23 percent in the criminal justice system; 20 percent in print and television news; and even less in the U.S. Congress.

Regardless of the exact causal linkages between all the above and children's healthy development, the facts remain it is difficult to grow up unscathed. More than 1 in 6 young people between the ages of 12 and 20 are either binge drinkers or heavy abusers of drug and alcohol; youth mental illnesses and depression have significantly increased in the past 10 years[8]; and the three leading causes of death for young people between the ages of 15-24 are unintentional injuries (e.g., auto accidents, drug overdoses), homicides, and suicides.[9]

Generation Z is the most culturally and ethnically diverse one in American history. The percentage of school-age children ages 5–17 in the United States who were non-White rose to 47 percent in 2013. This is not due primarily to an influx of immigrant children. Fully 97 percent of all children born in 2013 and who live in the United States were born here.[10]

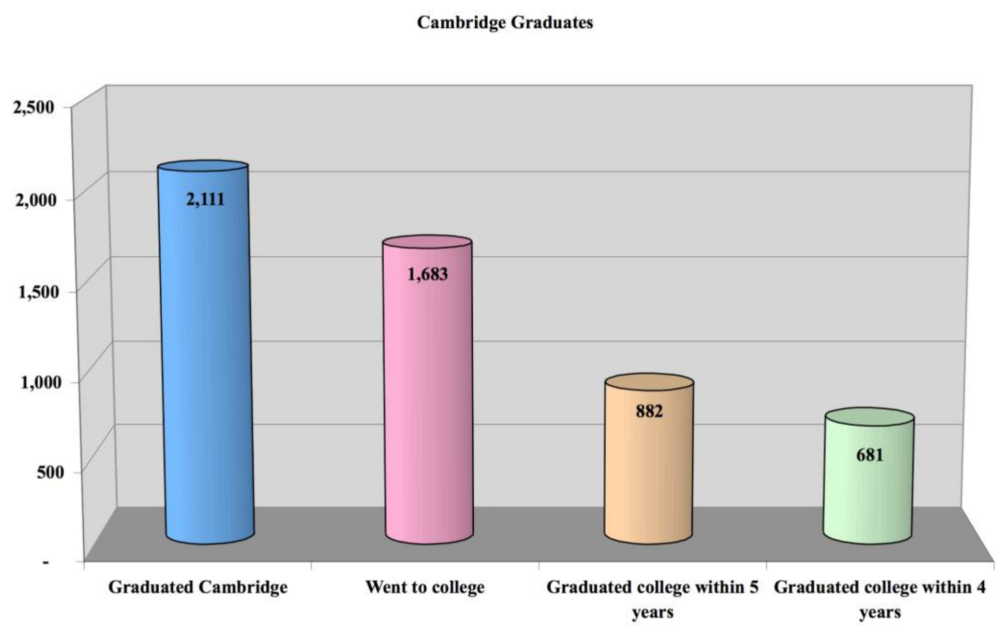
At the same time, today's high school students must be prepared to work and live in a wider world where there are many existential problems that confront the world in the 21st century, such as global climate change and threats of nuclear terrorism, will soon face them as adults. They need to be prepared for a world that is rapidly moving into unchartered territory. They must be able to use their minds wisely and ethically to meet old and unforeseen new challenges. They will need to possess informed and critical insight to distinguish real from fake; truth from myth. For Generation Z, learning that does not help them discover meaning and how to tell, the genuine from the counterfeit is vacuous and ultimately pointless. Given that pK-12 public education is the last remaining public institution having the most contact with and potentially beneficial influence upon Generation Z, it is time we reexamine and rethink the core purpose of high school education. What should the curriculum content of high school be in light of these harsh realities and challenges to healthy, sustainable human and social development in the 21st century?

2. The Simmering College and Career Crisis

College and career readiness has been the guiding mantra of state and federal policymakers since the mid-2000s. It still is. It is the stated aim of most high schools, especially elite private and exclusive charter schools, whose headmasters routinely cite the numbers and percentages of their graduates being accepted to various colleges as evidence of the school's quality. Yet mere admission to college can be a mirage.

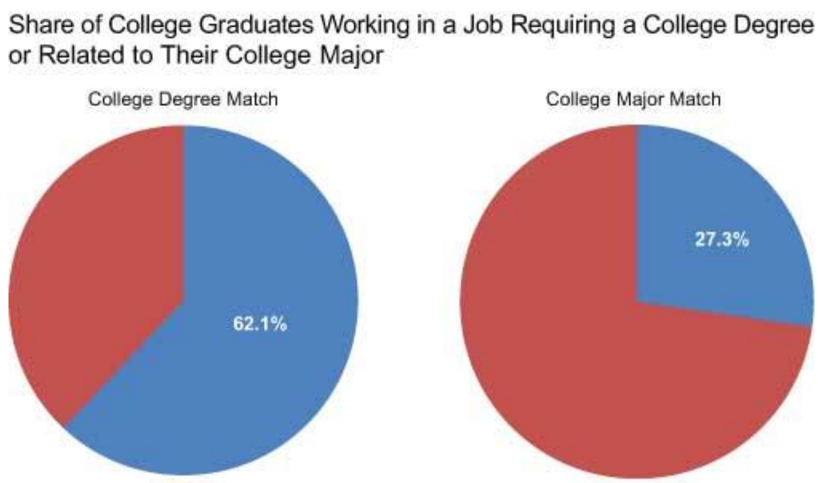
The available evidence is that many high graduates are not prepared to academically or emotionally complete college. Many college students suffer from depression and anxiety. A 2016 national survey of 95,571 college students from 137 post-secondary schools found that over the past 12 months: 82 percent felt exhausted; 65 percent felt very sad; 58 percent felt overwhelming anxiety; 50 percent felt things were hopeless; 37 percent felt so depressed that it was difficult to function; 10 percent seriously considered suicide; 7 percent intentionally cut, burned or bruised themselves; and 1.5 percent attempted suicide.[11]

Perhaps the emotional condition of today's college student can be dismissed as the necessary price to pay for a rigorous collegiate education and degree which will be the ticket to a brighter future. Undoubtedly this is the case for many. But for many others, the academic picture is not as rosy. At Cambridge High School,[12] for example, located in an affluent, predominantly White suburb, where 60 percent of the residents have a college degree, out of a graduating class of 2,111 students only 32 percent of Cambridge's high graduates completed college in four years. The percentage completion rose to only 42 percent in five years.[13] This is quite remarkable given that a survey of college freshman found that 83 percent expected to graduate in four years from the college they had just entered.[14]



The fate of Cambridge high school graduates is not an outlier. The National Student Clearinghouse (NSC) tracks the college status of nearly all high school graduates in the United States who enroll in college. According to their latest report for the 2010 cohort of first time college enrollees, of the nearly ½ million students who enrolled at a private college or university in 2010, 74 percent finished any college in 6 years. The same year's cohort, of the 1.22 million other students who enrolled at public colleges, 62 percent of them graduated any college in 6 years. At two-year community college, of the 1.1 million enrollees in 2010 only 39 percent finished in 3 years.[15]

Meanwhile student loan debt now stands at $1.4 trillion, having nearly tripled in 10 years.[16] It could be argued that college debt, although burdensome in the short run, is an investment in future job earnings. This presumes there is a match between a job and a college degree and another match between a job and a college major. But economic analysts at the Federal Reserve Bank of New York have found that nearly 2 in 5 college graduates are working in a job that does *not* require a college degree and only about a quarter are working in a job related to their college major.[17]



Source: U.S. Bureau of the Census, 2010 American Community Survey; authors' calculations.
Note: Individuals with graduate degrees are not included in the calculation of college major matching because the information available on majors relates to the undergraduate degree.

This mismatch occurs even though many skilled technical positions go begging. The Manufacturing Institute of the National Association of Manufacturers, for example, states,

> "a skilled, educated workforce is the single most critical element of innovation success — and the hardest to acquire. *U.S. executives rank the difficulty of finding high-quality talent* among *their top "pain points,"* citing a lack of skilled workers at both the engineering and the basic-skills level. The bottom line: a skilled, educated workforce is the most critical element for innovation success, and countries and states with strong education systems do better in the global battle for innovation leadership."[18]

Fundamentally, "college and career readiness" as the core purpose of a high school education is fraught with practical and political problems. One major practical problem is matching students' high school preparation to a particular collegiate field of study. The National Survey of College Graduates (NSCG) lists 27 broad areas of possible fields of study.[19] Even if we ignore the many possible majors under these 27 broad areas, such as the area of "Liberal Arts," which includes the fields of anthropology, history, economics, literature and political science, how can a high school education prepare a student for all of them? We could try to collapse these 27 broad categories into larger, but fewer, categories. Then students in a high school could be surveyed for their areas of interest to better focus the content of their high school course preparation. But we soon face the problem of trying to account for students' changing their initially declared major to some other field of study. According to a National Center for Education Statistics (NCES) report (2013),

> A total of 48 percent of bachelor's degree students and 69 percent of associate's degree students who entered STEM fields between 2003 and 2009 had left these fields by spring 2009. Roughly one-half of these leavers switched their major to a non-STEM field, and the rest of them left STEM fields by exiting college before earning a degree or certificate. Attrition rates in non-STEM fields were as high as or higher than those in STEM fields. At the bachelor's degree level, students in humanities, education, and health sciences had higher attrition rates (56−62 percent) than did those in STEM fields (48 percent), and students in business and social/behavioral sciences had comparable attrition rates (50 and 45 percent, respectively) as did students in STEM fields.[20]

It could be argued that the job of a high school education is not so much to prepare a student for a particular collegiate field of study. Instead, the main job of high school, it could be argued, is to instill certain habits of mind and behavioral characteristics to enable them to persist and succeed once in college in whether field they choose to study. These "21st century skills" include: "critical thinking and problem solving," thinking creatively, and communicating and collaborating with others.[21] Other researchers cite certain behaviors as being associated with college success, such as time management, self-responsibility, self-initiative, persistence, having realistic expectations, and engaging peers and faculty.[22]

All of the above skills and characteristics are no doubt helpful to a person in college as well as life in general. But by themselves, they do not provide sufficient guidance as to the *content* of a high school education. Thinking creatively, for example, is not something that can be done apart from an object to think creatively about any more than "redness" exists apart from an object that is red. Redness is an abstraction from many instances of concrete objects. Thus, 21st century skills and other behavioral characteristics cannot be taught or instilled in a person apart from the specific objects of knowledge and experiences which are the occasion for their development and expression. As a practical matter, then, we are left empty as to what should be the content of a high school curriculum?

Kenneth Adelman's work provides some insight into the relationship between high school course taking and college success.[23] Adelman found that a student's "academic intensity" in high school, such as taking more advanced math courses, was predictive of later college success, e.g., the more math courses taken the greater likelihood of college degree completion. See the table below.

Table 5. Bachelor's degree attainment rate by highest level of mathematics reached in high school by 1982 and 1992 12th-graders

	Class of 1982		Class of 1992	
Level of math	Percentage reaching this level of math	Earned bachelor's	Percentage reaching this level of math	Earned bachelor's
Calculus	5.2 (0.36)	82.1 (2.45)	9.7 (0.54)	83.3 (2.72)
Precalculus	4.8 (0.37)	75.9 (2.43)	10.8 (0.65)	74.6 (2.04)
Trigonometry	9.3 (0.51)	64.7 (2.32)	12.1 (0.81)	60.0 (3.32)
Algebra 2	24.6 (0.75)	46.4 (1.54)	30.0 (1.08)	39.3 (2.31)
Geometry	16.3 (0.65)	31.0 (1.92)	14.2 (0.87)	16.7 (1.87)
Algebra 1	21.8 (0.69)	13.4 (1.33)	16.5 (0.92)	7.0 (1.24)
Pre-algebra	18.0 (0.66)	5.4 (1.19)	6.7 (0.53)	3.9 (1.34)

NOTES: Standard errors are in parentheses. The columns for level of math may not add to 100.0 percent due to rounding.

These correlations led to national philanthropies, principally the Bill and Melinda Gates Foundation, to fund projects to encourage students to complete Algebra 2 under the theory that Algebra 2 course completion was a key gateway to college success.[24] As it would turn out, however, defining and administering a common end-of-course Algebra 2 test for participating states resulted in many students doing very poorly.[25] Even so, according to Adelman, only 40 percent of those students whose highest math course was Algebra 2 went on to earn a Bachelor's degree. Yet for those who successfully completed advanced math courses in high school, Adelman could not determine the *causal* relationship between these specific high school courses and later college success. It could be the case that advanced academic course taking in high school, such as calculus courses, is rather a *marker* for motivational characteristics, or financial resources or other opportunity-to-learn factors, such as quality teachers and private lessons. Moreover, Adelman had to work within the existing configuration of most high school courses. His was a retrospective analysis - not an experiment. Thus, it is not possible to determine from his work whether *other* possible curricular courses and pedagogical approaches reflecting different purposes to a high school education could be equally influential to a student's later college and career success. It could turn out, for example, that real world internships with informal educational and business entities could be far more determinative of later college success than Algebra 2 classes.

We might be able to salvage the assertion that a high school's core purpose should be about college and career success by proposing a scheme whereby high school graduates are followed into college from a particular high school. Then, their high school courses, grades and other experiences could be correlated with their college outcomes to determine the most influential factors. In turn, based on this feedback loop, the high school curriculum and extra-curricular experiences could be iteratively reversed engineered to more closely align with those associated collegiate outcomes. Such a feedback system might yield surprising findings. But politically, the establishment of such a feedback system seems highly unlikely. What school board, for example, would voluntarily tell their local taxpayers that only 30 percent of their district's graduating seniors completed college in four years? Far better to boast that 90 percent of the senior class *intends* to go to college! Likewise, how many parents would let their teenagers forego Advanced Placement (AP) courses for a project-based internship unless they could be assured that the latter would give their children a leg up in admission to a highly competitive college? Thus, we are left in the grip of a vicious circle. Undesirable college and career outcomes are partly due to an inadequate high school education system. That system in turn is unable to correct its shortcomings due to both the existence of real practical and political issues of matching high school courses to college majors and completion patterns.

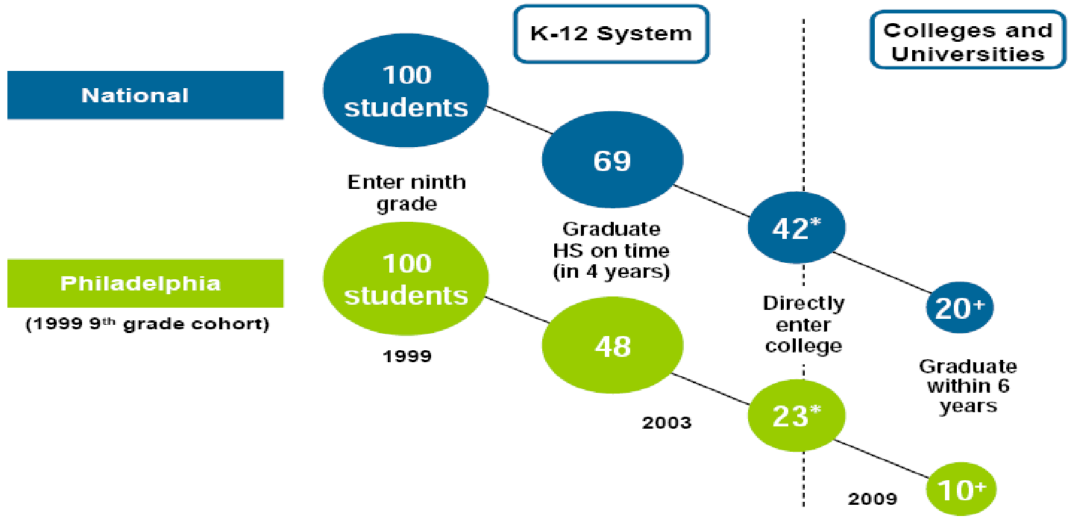
Bill Gates, founder of Microsoft, summed up this college and career crisis more than ten years ago in an address to the National Governors' Association's (NGA) National Education Summit on High Schools where he claimed America's high schools are obsolete,

> When we looked at the millions of students that our high schools are not preparing for higher education – and we looked at the damaging impact that has on their lives – we came to a painful conclusion:
>
> **America's high schools are obsolete.**
>
> By obsolete, I don't just mean that our high schools are broken, flawed, and underfunded – though a case could be made for every one of those points.
>
> By obsolete, I mean that our high schools – even when they're working exactly as designed – cannot teach our kids what they need to know today.
>
> Training the workforce of tomorrow with the high schools of today is like trying to teach kids about today's computers on a 50-year-old mainframe. It's the wrong tool for the times.
>
> Our high schools were designed fifty years ago to meet the needs of another age. Until we design them to meet the needs of the 21st century, we will keep limiting – even ruining – the lives of millions of Americans every year. [26]

3. Urban Settings: The Philadelphia Context

Student outcomes in Philadelphia high schools vividly demonstrate the problems of using "college and career success" as the organizing principle for the core purpose of a high school education. In a study that tracked the 1999 cohort of the City of Philadelphia's 9th grade students into college, only 23 percent managed to enter college, and only 10 percent finished any type of college within six years.[27] Even if we accept these 10 percent of 9th graders who competed college went on to have career success, what about the 90 percent who did not finish college? Was their high school education then a waste?

While high school graduation rates improved from 48 percent in 1999 to 65 percent in 2015, more than one-third of all of the City of Philadelphia's 9th grade students in 2011 did not graduate high school in four years.[28] This is troubling because 65 percent of all 20-24 year olds in the Philadelphia region, without a high school diploma do not have a job. [29] Furthermore, one in four young persons between the ages of 18 and 24 are disconnected from the labor market - neither employed, nor in school.[30] How did high school prepare them?



This state of affairs is not because of the size of Philadelphia's metro economy.[31] It has a Gross Metropolitan Product (GMP) of over $352 billion, ranking it 7th in the nation and making this region effectively the world's 32nd largest economy.[32] Within the Philadelphia is regional economy there are nearly three million workers. According to an analysis by IHS Global Insight,

> "Critical to the nation's economic recovery – and future health – are metro economies. They are home to 83.7% of the nation's population, 85.8% of the jobs, 89.9% of the wage and salary income, and 90.7% of the country's real GDP".[33]

Nonetheless, the Greater Philadelphia economy faces three major challenges: the quality and quantity of talent for federal contracting needs and business innovation and growth; the widening income gap between workers and upper management, and the chronically under and unemployed. The Economy League of Greater Philadelphia convened over 1,000 leaders to provide input on what a world class future should look like. One of their three main conclusions was that while Greater Philadelphia had,

> "a large, skilled workforce and its higher education institutions are considerable assets…*the region faces significant challenges in equitably delivering K-12 education,* providing access to quality early childhood education, and meeting the evolving needs of the region's employers to compete in the global economy."[34]

The current trajectory of Philadelphia area high school student performance does not provide a great deal of optimism for the future. In the 11th grade Keystone exams for 2015-2016, where students can take the exams multiple times, Philadelphia students scored either Proficient or Advanced in the following percentages:

PA Keystone Exams Philadelphia	**Proficient or Advanced 2015-16**
Algebra I	43%
Biology	36%
Literature	55%

Please note this: we are **not** saying urban youth should not be prepared for higher education and eventually find a fulfilling career. Nor are we saying that it is pointless for them to aspire to go to college - quite the contrary. Rather, we are saying that a high school education should have a value proposition *in its own right*. Its core purpose should be one that can be fulfilled *during the course of high school*, and judged as having met that purpose by the end of high school. To couch the purpose of high school as *only* preparation for college is analogous to saying the purpose of Algebra 1 is to prepare students for Algebra 2; and the purpose of Algebra 2 to prepare students for Trigonometry, and so on. The hard questions about the purpose of high school is instead deferred to a future point which may or may not ever be fulfilled, or which may have had little actual value for future jobs as we previously documented.

A high school education should have an engagement proposition, that is, meaning and value, to the lives of adolescents as they are *in the present moment*. College and career success should be a *result* of having sufficiently engaging and intellectually demanding high school level courses and learning experiences so that a person is then ready for higher learning wherever and whenever it may take place. But the purpose of educating children is not only, or even primarily, defined by whether it supposedly promotes a vaguely worded goal in the future. As we have seen, “college success” is a dubious organizing principle for a high school curriculum in practical terms. Learning to read is necessary for college, but its primary value is not defined chiefly by that goal. The value of learning to read has both immediate as well as future value in many learning endeavors apart from college. Likewise, the purpose of a high school education should be determined by the value it brings to the adolescent’s emotional, social and intellectual development *on its own merits*. If “college and career readiness” is the only purpose to high school, then we need to rethink its core purposes to restore its intrinsic value and relevance to young people. Otherwise, the millions of children who attend and graduate high school, but not college, have wasted their time. And, even those who manage to complete college many see high school as only a way station whose ticket they needed to have punched.

In the next section we briefly recount past efforts to rethink and reform high schools.

II. Rethinking High Schools- The Problem of Core Purpose

4. The Small Schools Movement Falls Short

In the span of seven years from 2000-2007, the Bill & Melinda Gates Foundation invested more than $1.7 billion to redesign and reform hundreds of high schools.[35][36] One of the key theories of the Gates initiative was the idea that high schools have to be small enough so that teachers could better get to know their students. In small school, students could better develop a sense of community and relatedness with adults and their peers. For the Gate's Initiate, the ideal size of the high school was less than 400 students, but certainly no more than 600.

Gates initiative was not the first to advocate and support small high schools. In 1988, the Pew Charitable Trusts invested $16 million to break up Philadelphia's large comprehensive high schools into "schools within a school," or "charters." Each charter contained between 200-400 students and was run by a team of 10-12 teachers. The idea was to develop a sense of relatedness and community by having the teachers and students remaining together for four years. Ninety-seven (97) charters were supported by the Pew Trust through the Philadelphia Schools Collaborative, a nonprofit intermediary set up specifically to run the program.[37] But the core purpose of the school was left underdeveloped. The architecture of the curriculum was left in the hands of each 10-12 member teacher team. These teacher teams were given a common planning time to create curricula and determine their instructional methods. Conceivably, with 97 charters there could be 97 different versions of the curriculum for each subject.

In 1995, after Superintendent Constance Clayton had retired, her successor David Hornbeck, with a $50 million grant from the Annenberg foundation,[38] ushered in an elaborate district-wide "Children Achieving" agenda that included his plan to replace charters with Small Learning Communities, or SLCs, at the high school level that would be networked with k-8 feeder schools to form a network of 22 k-12 clusters.[39] Hornbeck's arrival in 1995 coincided with the full blossoming of the curriculum standards movement in the mid-1990s. And so, the curriculum of his Small Learning Communities theoretically became more uniform in that the subjects had to be aligned to the Pennsylvania content standards. But amid chronic complaints from teachers for more curricular guidance, it was not until 2000, the fifth year of Hornbeck's Children Achieving reform plan, that the central office began developing a districtwide curriculum. Unfortunately, by that time, the central office curriculum departments of the Clayton era had been largely dismantled. That same year, in June 2000, Hornbeck resigned and with it his Children Achieving SLC plan was gone.[40][41]

The Gates Foundation's small school initiative begun in the late 1990s, and extending into the first decade of the 21st century, tried to finesse the problem of defining the core purpose for their high schools by listing seven "Attributes of High-Performing Schools."[42] One of the seven attributes, "High Expectations," was described as follows:

> "Staff members are dedicated to helping students achieve state and local standards; students are engaged in an ambitious and rigorous course of study; students leave school prepared for success in work, further education, and citizenship?"

But content standards are not a curriculum and much less the overall aim of a high school education. We have seen that the stated purpose of "preparation for further education" is too vague to guide the content and scope and sequence of a high school curriculum because a purpose must be stated *in terms other than itself.*

While the attributes of Gates small school may be desirable, the question as to fundamental purpose of the public high school was left begging. What exactly is "an ambitious and rigorous course of study"? What determines which courses of study should be chosen out of the many possible lines of student inquiry? Should it be a religious school, a music school, a school to train engineers, a school to teach young people the ways of peace and nonviolence? Should high school students learn how to cook a meal, how a car works, how to fix a faucet, how to minimize risk to their life? Even if we were to accept, for the sake of argument, that the core purpose of small high schools in urban settings is to prepare their students for "college success," then it must be asked, how well are they doing, which as we noted previously, is very poorly.

The issue of small schools as a desirable attribute was well settled in the 1990s, before the Gates Foundation small schools initiative. Small schools do possess certain advantages over large schools. These advantages include much less truancy, greater safety and school order and far fewer dropouts. [43] More recent research on New York's and Chicago's small school program continues to show these salutary effects, no doubt due to the possibilities for more personal relationships their small size affords.[44] [45] [46] Nonetheless, school size does not determine its core purpose; it must be only considered one possible tool to achieve a clear purpose, which was still lacking in many small schools supported by Gates and other foundations.

The table below is from a study done by MDRC on postsecondary outcomes of students from New York City's small public high schools of choice (SSC). The data was gleamed from the National Student Clearinghouse. It will be noted that a greater percentage of students from the SSCs were enrolled in the first semester of their fourth year in college. This has been taken as an improvement over a control group of counterpart and it is. (What is unknown as yet is how many students eventually completed college.) Nonetheless, 75 percent of SSC students *did <u>not</u> make it to the fourth year*. [47] This is no criticism of the undoubtedly strenuous effort by the staffs of these schools. As other studies have shown, other factors can come into play that can affect eventual college completion. But if the principle purpose of a high school education is preparation for college success, then at least 75 percent of these students from SSC are left holding an empty bag. How has high school been of use to them? Some may argue that to *not* to try to prepare all students for college, especially those who are poor and disadvantaged, is elitist, prejudicial and inequitable at best and racist at worst. This is a false Hobson's choice. Is it not possible for a high school education to have both intrinsic and immediate value to a student *and* also equip them to pursue higher and further learning if they so choose?

TABLE 4. SSC Effects on Persistence in Postsecondary Education After Graduating from High School in Four Years: Cohort 1

OUTCOME IN FOLLOW-UP PERIOD (%)	TARGET SSC ENROLLEES	CONTROL GROUP COUNTERPARTS	ESTIMATED EFFECT	P-VALUE FOR ESTIMATED EFFECT
POSTSECONDARY ENROLLMENT				
YEAR 1[a]	44.4	37.6	6.8[b] *	0.011
YEAR 2	37.6	31.3	6.4 *	0.040
YEAR 3	31.7	25.8	5.8 *	0.046
FALL OF YEAR 4	25.1	19.5	5.7	0.064
POSTSECONDARY DEGREE COMPLETION				
FALL OF YEAR 4	3.7	2.3	1.4	0.096

NOTES: Findings in this table are based on data for 4,473 participants. See notes to Table 1 for an explanation of how SSC effects were determined. Some findings may not sum exactly due to rounding error.
A two-tailed t-test was used to assess the statistical significance of each SSC estimated effect with significance levels indicated as ** = 1 percent and * = 5 percent.
[a]Year 1 includes students who enrolled in a postsecondary institution at any point in the first year after four-year high school graduation.
[b]While the overall effect for students in all four cohorts who graduated from high school in four years and enrolled in a postsecondary institution the next year is 8.4 percentage points (see Table 1), this table looks only at students in cohort 1, where the effect is 6.8 percentage points.

At the same time of the Gates Foundation small high school investments, the number of secondary[48] public charter schools has more than tripled from 467 schools in 2000 to 1,521 schools in 2014. Secondary magnet schools likewise nearly tripled in number from 328 to in 939 schools during the same time span. Secondary student enrollment in magnets and public charter schools also increased nation-wide from 3.7 percent to 10.4 percent. [49] But they are subject to the same critique. If high schools are to be rethought in the form of charters or magnets, their core purpose or aim must be articulated such that it can serve as guide for making decisions about what to teach and how to teach it.

Different core purposes should have different curricular consequences regardless of the governance of the school. If 9th grade mathematics, for example, still consists of Algebra 1 as an exercise in symbol manipulation, then this is a sign that the rest of the curriculum has not likely fundamentally changed. Merely saying the purpose of high school is to “fulfil students’ potential” is insufficient to guide curriculum design since a student’s potential is always measured relative to particular curriculum content. If left for schools to define, a child’s potential becomes a circular argument that serves to maintain the status quo. Without greater precision about the core purpose of a high school education, the default condition is what has been - new labels and the use of whiz-bang technology notwithstanding.

5. The Rise of STEM Schools

Paralleling the Gates Foundation's secondary small school effort and the rise in secondary charter and magnet schools has been a steady rise in STEM (science, technology, engineering and math) schools. In 2008, a Gates Foundation commissioned study catalogued about 315 self-identified STEM schools in the Unites States.[50] It is true that special admission science schools for advanced students have existed for some time, such as the Bronx High School for Science in New York City and the Carver High School of Science and Engineering in Philadelphia. In contrast to these more traditional science high schools, STEM schools for advanced students had a somewhat broader purpose than college preparation. New global, science-related issues and technological advances were evident in the design of STEM schools. These schools sought to differentiate themselves from existing specialized science schools by emphasizing more the "T and E" in STEM, such as the use of computer, internet and digital fabrication technologies, and trans-disciplinary projects using an explicit engineering design process.[51] Reports and popular books such as Thomas Friedman's, *The Earth is Flat*, highlighted the role of convergent digital technologies and collaborative entrepreneurship in the 21st century knowledge economy.[52]

In the first decade of the new millennium, the creation of STEM schools was spurred by many national leadership business and academic groups, such as the National Academy of Sciences (NAS),[53] the Business Roundtable,[54] the Business Higher Education Forum, and the National Governors Association,[55] who sounded alarms over the potential loss of U.S. leadership in innovation and its impact on our global competitiveness and domestic prosperity. One element of this concern had to do with cultivating talent for cutting edge research and innovation. For example, the preface to NAS report, *Rising above the Gathering Storm,* quoted Nobel Laureate Julius Axelrod's dictum that. *"Ninety-nine percent of the discoveries are made by one percent of the scientists."* The NAS report went to assert that,

> "The prosperity the United States enjoys today is due in no small part to investments the nation has made in research and development at universities, corporations, and national laboratories over the last 50 years." [56]

A second closely related concern was and still is the perceived looming shortage of advanced STEM talent due to the anticipated retirement of baby boomers, particularly those related to national defense. A significant portion of employees, for example, in the Department of Defense's science and technology laboratories are projected to leave by 2020 through retirement or attrition. Many of these positions require security clearance and US citizenship. In 2005, workers aged 45 and older constituted 57.8 percent of all federal scientists and engineers.[57] More than two-thirds of NASA employees, for example, are scientists and engineers, many of whom are nearing retirement. Private-sector industries, such aerospace and IT businesses also have the need to replenish their aging skilled workers as well as make new hires. The President's Council of Advisors on Science and Technology (PCAST) cited economic projections which noted "*approximately 1 million more STEM professionals* [will be needed] *than the U.S. will produce at the current rate over the next decade, if the country is to retain its historical preeminence in science and technology.*[58]"

In September 2010, the PCAST issued a report summarizing the case for STEM education:

> The success of the United States in the 21st century – its wealth and welfare – will depend on the ideas and skills of its population. These have always been the Nation's most important assets. As the world becomes increasingly technological, the value of these national assets will be determined in no small measure by the effectiveness of science, technology, engineering, and mathematics (STEM) education in the United States. STEM education will determine whether the United States will remain a leader among nations and whether we will be able to solve immense challenges in such areas as energy, health, environmental protection, and national security. It will help produce the capable and flexible workforce needed to compete in a global marketplace. It will ensure our society continues to make fundamental discoveries and to advance our understanding of ourselves, our planet, and the universe. It will generate the scientists, technologists, engineers, and mathematicians who will create the new ideas, new products, and entirely new industries of the 21st century.[59]

The aforementioned reports not only called for a greater emphasis on STEM enrollments, but also a different kind of curricular and instructional approach to education. Typical of these calls for action was the National Innovation Initiative (NII) launched in 2005 by the U.S. Council on Competitiveness, a nonpartisan leadership organization of corporate CEOs, university presidents, labor leaders and national laboratory directors. The NII urged a,

> "retooling [of the] curricula from kindergarten through graduate education, creating an 'innovation culture' at all levels, and providing students opportunities to explore open-ended problems, engage in teamwork, and work on projects that cross traditional disciplines." [60]

Accordingly, key features of STEM schools are transdisciplinary projects and public-private partnerships which allow students to make meaningful connections with knowledge-based industries through internships and off-school site learning spaces. For example, in Cleveland, Ohio, MC^2 STEM High School's 10th grade building is physically located on General Electric Research campus allowing students to regularly interact with GE scientists.[61]

While academically selective STEM schools exist, such as Thomas Jefferson High School for Science and Technology (TJHSST) located in Fairfax, Virginia, one of the oldest STEM schools, there has been a growing interest in the establishment of non-selective, or semi selective, "inclusive" STEM schools as a means of offering expanded opportunity to historically underserved students. Examples of inclusive STEM schools are MC^2 STEM High School and Science Leadership Academy in Philadelphia.[62] There are two main motivations for this interest. The first is the moral imperative of equity, which has been codified in the No Child Left Behind Act of 2001 (NCLB) [63]and more recently in the Every Student Succeeds Act of 2016.(ESSA) [64] The second motivation is due to simple demographics. During the past 20 years, there has been a steady decline in both the absolute numbers and percentages of white students enrolled in pk-12. By 2020, projections are non-white students will comprise 55% of pk-12 enrollments compared to only 36% in 1997.[65] Hence, the 2010 PCAST report recommended that,

> "The Federal Government should promote the creation of at least 200 new highly-STEM-

> focused high schools and 800 STEM-focused elementary and middle schools over the next decade, including many serving minority and high-poverty communities" [66]
>
> …[STEM education] will provide the technical skills and quantitative literacy needed for individuals to earn livable wages and make better decisions for themselves, their families, and their communities. And it will strengthen our democracy by preparing all citizens to make informed choices in an increasingly technological world.[67]

Thus, inclusive STEM schools gained momentum in the first two decades of the new millennium as a means of better preparing students for emerging STEM related jobs.

Nonetheless, the core purpose of STEM schools as a pathway to STEM related careers remains an elusive proposition. Not all STEM jobs are in demand according to a 2015 U.S. Department of Labor (DOL) study.

> "The last decade has seen considerable concern regarding a shortage of science, technology, engineering, and mathematics (STEM) workers to meet the demands of the labor market. At the same time, many experts have presented evidence of a STEM worker surplus. A comprehensive literature review, in conjunction with employment statistics, newspaper articles, and our own interviews with company recruiters, reveals a significant heterogeneity in the STEM labor market: the academic sector is generally oversupplied, while the government sector and private industry have shortages in specific areas." [68]

Using a taxi-passenger queue as a metaphor, the DOL report noted the determination of STEM worker surpluses or shortages are dependent on the specific occupation, location and degree required. *"Some occupations have a shortage of qualified talent, such as nuclear and electrical engineering Ph.D.'s who are U.S. citizens; in other areas, such as biology Ph.D.'s aiming to become professors, there is a surplus."*[69]

In light of the uncertainty as to how to prepare high school students for STEM jobs, many of which do not as yet exist, some argue that the purpose of STEM schools should be to cultivate a generalized "STEM literacy." Just how such literacy would lead one to a STEM job is less clear.

Alas, the 2010 PCAST report offered no one core purpose to a STEM education that could serve as the organizing principle around which to configure other goals. Should a curriculum be structured to principally help "solve immense challenges," or to "advance understanding of ourselves" or to enable young people "to earn livable wages" or "to make better decisions for themselves, their families, and their communities" or "to strengthen our democracy by preparing all citizens to make informed choices"? Each of these aims has different implications for what to include in a curriculum, how to organize it, and how to present it to students. It is not that these many purposes of STEM education are not important or worthy. They all are. The problem is that one core purpose needs to serve as the organizing principle of the curriculum from which other, lesser aims can be then be fulfilled. But the PCAST report noted that most STEM focused schools are singular creations and have been difficult to scale.

Unable to pin down a core purpose to inclusive STEM schools, researchers have chosen the strategy,, as with the Gates Foundation small school initiative to instead note common attributes or features of STEM schools. These attributes of inclusive STEM high schools (ISHSs) differ from the attributes of the Gates Foundation's small schools in that they focus on more integrated courses, engineering and technology, transdisciplinary projects including capstones, and external connections to business/industry and science centers. (See table below). Two of the attributes deal with the ISHSs' curriculum and mission.

> "[A] STEM focused curriculum [of] strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects, and
>
> An inclusive STEM mission [whereby] the school's stated goals are to prepare students for STEM" [70]

These attributes, however, are of no help in defining a school's core purpose or aim because they are self-referencing or have the goal of preparation for still more STEM courses. A core purpose must reference a purpose beyond itself. Fortunately, there is an example of a set of STEM high schools with a clearly defined core purpose. They are in Egypt, although their design was created by educators in Philadelphia and Cleveland.

Critical Components of ISHSs

Name of Component	Definition
1. STEM-focused curriculum	Strong courses in all four STEM areas, or, engineering and technology are explicitly, intentionally integrated into STEM subjects and non-STEM subjects
2. Reform instructional strategies and project-based learning	STEM classes emphasize instructional practices/strategies informed by research for active teaching and immersing students in STEM content, processes, habits of mind and skills
3. Integrated, innovative technology use	The school's structure and use of technology has the potential to change relationships between students, teachers, and knowledge and flatten hierarchies
4. Blended formal/informal learning beyond the typical school day, week, or year	Learning spills into areas regarded as *informal STEM education* and includes apprenticeships, mentoring, afterschool clubs, and projects
5. Real-world STEM partnerships	Students connect to business/industry/world of work via mentorships, internships, or projects that occur within or outside the normal school day/year
6. Early college-level coursework	School schedule is designed to provide opportunities for students to take classes at institutions of higher education or online
7. Well-prepared STEM teaching staff	Teachers have advanced STEM content knowledge and/or practical experience in STEM careers
8. Inclusive STEM mission	The school's stated goals are to prepare students for STEM, with emphasis on recruiting students from underrepresented groups
9. Administrative structure	Include strength and organization of school leadership/principal, hiring/recruiting STEM teachers, arrangements/agreements with community, school-level data-driven decisions regarding instruction
10. Supports for underrepresented students	Bridge programs, tutoring programs, extended school day, extended school year, or looping exist to strengthen student transitions to STEM careers

6. The Egyptian STEM Schools – A New Model

In August 2011, a remarkable coincidence of events occurred. Earlier in the year, Egypt, a country of 85 million people, had been convulsed by a political revolution. For eighteen days, millions of people took to the streets in mass protests. Government was shut down. Its president of 30 years, Hosni Mubarak, was drummed out of office. The military took control. Egyptian protesters joined with millions of other protesters across eleven other Middle Eastern and North African (MENA) countries whose uprisings became known collectively as the Arab Spring.[71] Eventually, Egypt's governmental ministries started to function again, but revolution was still in the air. The Minister of Education, Dr. Ahmed Gamal el Din Moussa and his Deputy, Dr. Reda Abouserie decided to seize the moment and embark on a bold attempt to establish a new model for public high schools – an education revolution inside a political revolution.

In Egypt, all public high schools have the same curriculum. Its 17 million students all take the same high stakes exams that determine their future. Drs. Ahmed Gamal and Reda wanted something totally different - a model of how to transform Egypt's severely underperforming high schools. They decided to establish a Model STEM High School outside of Cairo in a suburb called 6 October City. It was to be a residential school of 450 boys selected from the best and brightest throughout Egypt. The school was to open in September 2011. There were only two problems: there was no curriculum and the teachers had received no professional development. Drs. Ahmed Gamal and Reda turned to the Egyptian office of the U.S. Agency for International Development (USAID-Egypt) for assistance. The U.S. State Department provides assistance through USAID missions in over 100 countries. Historically, Egypt is second to only Israel in receiving the largest amount of U.S. aid.

In August 2011, a small contract was awarded to *World Learning* (WL), a nonprofit company with offices in Washington, D.C, to arrange a "study tour" of U.S. STEM schools for an Egyptian Ministry of Education delegation, led by Minister Ahmed Gamal el din himself. WL in turn contacted Global Philadelphia, (formerly the Philadelphia International Visitors Center,) for help. *Global Philadelphia's* core program is the "State Department's prestigious 'International Visitor Leadership Program.'"[72] But neither World Learning nor Global Philadelphia knew anything about STEM. So Global Philadelphia did what most people would do. They conducted a Google search for STEM education and found the *21st Century Partnership for STEM Education* (21PSTEM*)*, a nonprofit research and action organization located just outside of Philadelphia. Fortuitously, F. Joseph Merlino, president of 21PSTEM, and his staff had been studying STEM schools in the United States for the past year. Merlino enlisted the help of a colleague, Ms. Jan Morrison, president of *Teaching Institute for Excellence in STEM* (TIES) based in Cleveland, Ohio, whose company had a national reputation for establishing STEM schools in the U.S. He also enlisted the help of Dr. Frederic Bertley, Senior Vice President for Science Education at the Franklin Institute (TFI). TFI had established a STEM high school in 2006 called Science Leadership Academy (SLA). The Egyptian delegation spent four days in Philadelphia and were impressed by what they saw and heard.

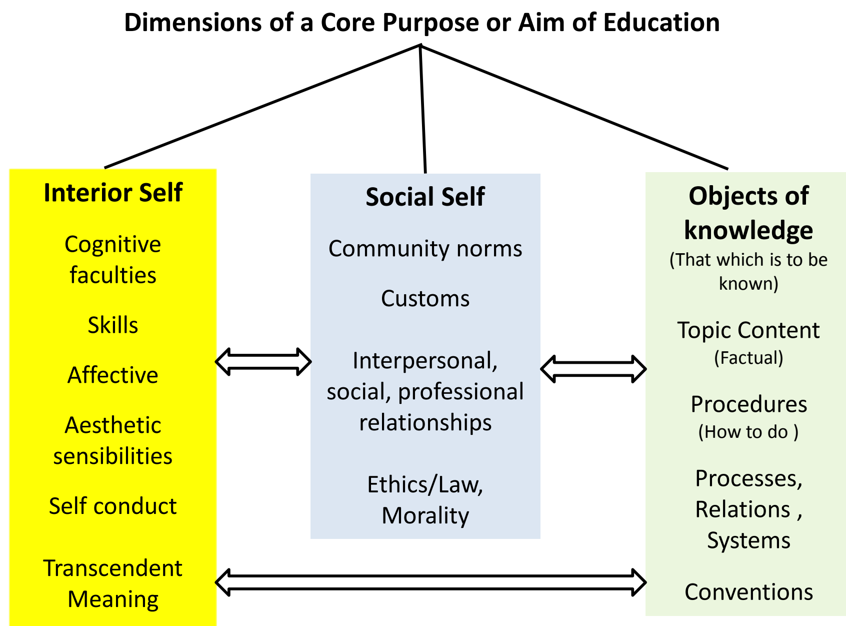
Within a few months after the Egyptian delegation departed the U.S., World Learning received a short term contract from USAID-Egypt to provide emergency technical assistance to the teachers at the new 6 October STEM school. World Learning invited 21PSTEM, TIES and TFI to become their STEM partners. The trio of STEM partners traveled to Cairo in January

2012 to get a first-hand view of the new 6 October STEM school and assess their needs. At meetings with top ranking USAID-Egypt and Ministry of Education officials, the U.S. STEM team concluded that the 6 October STEM school had great potential as a model but cautioned that it would require much more sustained support.

In March 2012, USAID-Egypt issued a Request for Proposal for a $25 million four-year grant to provide support to 3-5 Model STEM schools in Egypt. World Learning again invited 21PSTEM, TIES and TFI to be their partners. In August 2012, in the midst of ongoing political upheavals in Egypt, WL was awarded the grant. 21PSTEM's role was to lead the design of a new STEM curriculum and assessment system. The U.S. STEM team, whose staffs were already well versed in STEM school design across many states in the U.S., took everything they knew about innovative curriculum, assessment and technology, and put it into designing these new Egyptian Model high schools, the likes of which the Egyptians had never seen.

The first step was to figure out a core purpose or aim for the STEM school. An aim has three dimensions. These dimensions are not separate, but rather interpenetrate each other.

1) The cognitive faculties, skills, and disposition to be developed *within* each student;
2) The relations to be cultivated and nurtured *between* each student and others;
3) The content knowledge, procedures, processes and conventions students should learn including knowledge about themselves, other people and other objects in the natural and human-made world.



F. Joseph Merlino, *The 21st Century Partnership for STEM Education* (copyright)

21PSTEM created a unique18-step curriculum design process. The first three steps involved engaging a variety of Egyptian teachers and Ministry of Education officials in a series of "design studios" to articulate an aspirational vision for their country. Design studios are facilitated creative group thinking sessions with sequenced focus questions. Data from each session is used to structure subsequent sessions. The product of the first Egyptian design studios was to articulate clear core purpose to the new STEM schools: "to equip students to address Egypt's Grandest Challenges." Ten Grand Challenges were identified. Based on data gathered from these conversations, a set of educative goals was then entered into a table and crossed with formal coursework and informal learning experiences.

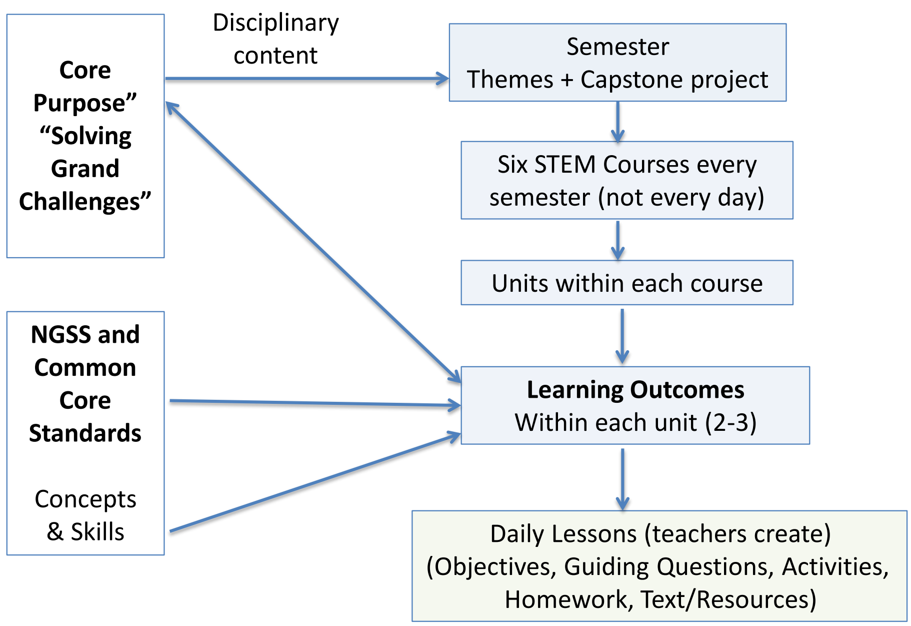
Eight Educative Goals Based on 6 October STEM School Design Principles	Framework for the STEM School Curriculum					
	Formal programs of study			Informal learning		
	Classroom courses	Labs	Capstone Projects	Internships	Extra-currcular activities	Residential life
What subject matter 6 October Students will learn						
The scientific mathematical and social dimensions of **Egypt's grandest challenges as a countr**y						
The content and ways of knowing that display of scientific, mathematical and technological literacy and subject matter proficiency						
What 6 October Students will develop within themselves						
Self-motivation, self–direction and a hunger for continued learning;						
The ability to think independently, creatively and analytically;						
The ability to question, collaborate and communicate at a high level						
How 6 October Students will relate to the wider society						
To be socially responsible leaders						
Able to apply their understanding to advance creativity, innovation and invention with a real-world vision with a consciousness and eye toward a more contemporary Egypt						
Be admitted to and successful in a university course of studies and then in the Egyptian labor market as well as the world labor-market;						

During January 26-28, 2013, a series of three all-day design studios were held involving 60 Egyptian teachers, university faculty members, and Ministry of Education officials. The goal was to identify specific disciplinary and interdisciplinary topics in biology, chemistry, geology, physics, mathematics and mechanics judged to be necessary for students to able to address Egypt's Grand Challenges. The inclusion of university faculty was critical to ensure breadth and depth of content as well as to ensure the topics taught in the STEM school would prepare students for future university coursework in the same discipline. These three days constituted Steps 4, 5 and 6 of the curriculum design process.

Over the next five months teams from 21PSTEM and TIES utilized the data collected from the January. 2013 design studios to construct a six-semester scope and sequence of integrated STEM courses and semester capstones. Each course has a set of high value learning outcomes (LOs) of about 1-2 weeks in length. Two to three LOs would comprise a unit of study and 10-15 LOs would comprise a year-long course. All six STEM subjects were taught every semester, but not every day. This allowed LOs from different subjects to be aligned and integrated. Feedback was then solicited from the Egyptians and revisions were made. These activities constituted Steps 7, 8 and 9 of the process.

The Learning Outcomes are informed by and aligned to the Next Generation Science Standards and the Common Core Standards in Mathematics, but they did not originate from them. They originated from the content necessary to develop students' ability to address the Grand Challenges. The standards are there, but in the background. For students, the reason to learn is to able solve their country's big challenges - that is the engagement proposition. A second thing to note is that the curriculum stopped short of specifying daily lessons. This task was left for the teachers.

Egyptian STEM School Curriculum Structure



In July and August 2013, textbook and laboratory materials were identified and matched to each Learning Outcome. Feedback was sought and teachers were then provided extensive professional development in August and September 2013. (Steps 10, 11 and 12) By the end of

September, 2013, the Egyptian STEM school integrated curriculum was rolled out in the 6 October STEM school for boys and a new STEM school for girls in the Maadi section of Cairo. (Step 13). In successive years, revisions were made to integrated STEM curriculum based on experiences in the classroom. Versions 2.0 and 3.0 were produced. (Steps 14-18).

The results have been phenomenal. Egyptian STEM school students have won many international science competitions, which is unprecedented in Egypt. For example, in the first year of the new curriculum 1.0, in May 2014, a team of students from Maadi STEM School for Girls placed 4th in their category at the prestigious INTEL International Science and Engineering Fair (ISEF) in Los Angeles, CA, using a project they created as part of the school's structure-their semester capstone design challenge. Soon thereafter, Egyptian President Sisi announced his desire to expand the number of STEM schools to 27 schools across the country within the next few years. The next year, in May 2015, a team from Maadi placed first at ISEF in their category. Yasmine Mostafa, the first place winner, was widely celebrated in Egypt for her international showing. NASA even named an asteroid after her.[73] In September 2015, seven new STEM schools opened in Egypt using the same integrated curriculum 3.0 and in September 2016 two more schools opened bringing the total to eleven STEM schools. In January 2017, it was announced that a junior at Kafr elSheik STEM School, Amal el Saeedy, was awarded an honorary doctorate degree from the International German Cultural Center in Lebanon in collaboration with the Goethe Institute in Germany, for her patent in solar cell technology based on the work she did as part of the normal curriculum at the STEM school.[74] Four more STEM schools are planned to be opened in September 2017 bring the total number of schools to fifteen, all of which are using the same integrated STEM curriculum with semester capstones.

Maadi USAID 1.0.wmv https://www.youtube.com/watch?v=Zy33wq6_eK4

III. City as Classroom – A New Vision for Urban High Schools

7. Beginnings

The rollout of the Egyptian STEM curriculum 1.0 in September, 2013 proved it was possible to successfully backward design an integrated STEM curriculum derived from a clearly stated core purpose for a high school, in this case one based on Egypt's Grand Challenges. This was accomplished amid the chaos of two revolutions and six different Ministers of Education in Egypt. The U.S. STEM team wondered if it were possible to replicate the same 18-step curriculum design process in the United States. As it would turn out, in an ironic twist of fate, the U.S. team would have the chance to return to Philadelphia to test this possibility. Only it would not be a new high school STEM curriculum; but for a *STEAM* (Science, Technology, Engineering Arts and Culture, and Mathematics) high school and not for the best and the brightest, but for all students in the city where the classroom would be the city and its many informal scientific, arts and culture and historical assets.

Quite by coincidence, during the same month that the Egyptian curriculum 1.0 was being rolled out, John Brady, president of the Independence Seaport Museum in Philadelphia, invited F. Joseph Merlino to the museum to solicit his counsel as to the possibilities of incorporating more STEM into the museum's' future plans. This meeting was arranged through Michael Pahides who had a mutual connection. Brady, a sailor and shipwright, had overseen the Museum's boat building program for many years. He had been elevated to the Museum's presidency two years prior. When Brady asked Merlino for his recommendations as to how the Seaport Museum could incorporate more STEM, Merlino presented three options: 1) incorporate more STEM into the museum exhibits; 2) form more partnerships with nearby schools, or 3) think big and reimagine urban high school education where informal education assets like the Independence Seaport Museum could be seamlessly blended into a new high school STEM curriculum with a more relevant purpose for urban students. Brady said, "Let's do number 3!" Arrangements were made to invite Michael Norris, Vice President of External Relations of the Greater Philadelphia Cultural Alliance (GPCA) to a follow up meeting. Norris suggested STEM be expanded to include "Arts and Culture" as well as STEM, since the GPCA represented over 400 arts and cultural, historical and science education nonprofit organizations. So STEM became STEAM.

On February 20, 2014, Norris and Brady arranged a two-hour meeting at the Independence Seaport Museum with 20 informal education directors from arts, culture and science nonprofit organizations to present the STEAM concept. The School District of Philadelphia (SDP) directors of curriculum and external partnerships also attended. The STEAM concept received an enthusiastic response. Mr. Brady expressed his enthusiasm for children discovering the importance of physics by understanding how sailboats move. Using the resources of the Independence Seaport Museum, students could also learn the importance of the watershed geography of the Delaware River Basin, and the key biological and chemical concepts involved in ensuring their families can drink clean water free of contaminants, such as lead. Arts representatives where enthused about the chance to integrate the arts into a purpose-driven STEM curriculum. Cultural and historical societies were enthused about helping students gain insight into themselves and others by understanding the city's unique historical and cultural significance.

In March, 2014 a meeting was held with Steve Tang, president of the University City Science Center (UCSC); Saul Behar, UCSC's vice president and general counsel; and David Clayton, director of their Maker Space. Danielle Stollak, UCSC's STEAM Program Manager who had attended the February 2014 information meeting, arranged the UCSC STEAM meeting. Discussions involved UCSC's strong support for the STEAM concept and future funding efforts.

In April 2014, Merlino submitted a seven page pre-application to the U.S. Department of Education's Office of Innovation and Improvement (I3) for funds to begin the STEAM curriculum development process along the same line as had been done in Egypt. On a parallel track, sources of potential National Science Foundation (NSF) funding for STEAM were explored. On September 18, 2014 a meeting in Arlington, Virginia was held with seven NSF program officers and the STEAM Steering committee members, which also included Jan Morrison from TIES. The purpose of the meeting was to describe the STEAM project and the work accomplished in Egypt to determine if there was funding interest from NSF. Both the I3 and NSF entreaties eventually proved unsuccessful as the project did not fall within the portfolio of any one program funding category.

Pursuit of funding for the STEAM project then turned to local sources. The GPCA had good relations with the Barra Foundation in Wayne, Pennsylvania owing to several GPCA members having received prior funding support from Barra. A January 16, 2015 meeting was arranged by GPCA between Kristi Poling, a program officer at the Barra Foundation and Joe Merlino to discuss the project. A proposal was invited and submitted on April 21, 2015. It was favorably received. On June 30, 2015 a Barra Catalyst grant was awarded to 21PSTEM in the amount $150,000 to begin the design process.

The Greater Philadelphia STEAM initiative, while building on the success of the Egyptian STEM curriculum, differed from it in several important ways. First, the goal was not to design a "Grand Challenges of Philadelphia based curriculum" that merely replicated the Egyptian model. Instead, the aim or core purpose of the STEAM high school model would have to emerge from the design studios process conducted in Philadelphia without any preconceptions. Second, the curriculum had to be suitable for all students and not for only the very top achieving students. Third, the curriculum had to be designed so that the abundant assets of the city's business, medical and scientific centers, together with its many informal education arts, cultural, historical and scientific education organizations, could be part and parcel of the formal curriculum. A STEAM curriculum framework will organize otherwise powerful but disparate informal education experiences as a regular part of the formal curriculum. Fourth, the curriculum has to be sustainable and scalable for potential use by many Philadelphia area high schools either in full or in part. These four elements constituted the core design challenge of creating a STEAM curriculum.

Around the same time of the Barra Catalyst award, another coincidence occurred. A group of twenty-two national foundations had formed a STEM Funders Network (SFN) led by the Noyce and Samueli Foundations. In June, 2015 they launched a "STEM Ecosystem Initiative".[75]

The goal was, and is, to:

> Build out a National Community of Practice comprised of local, regional and state STEM Learning Ecosystems from across the country. Ecosystems will encompass preK-16 schools; community settings such as after-school and summer programs; institutions of higher education; STEM-expert organizations such as science centers, museums, corporations, intermediary and non-profit organizations or professional associations; businesses; funders; and informal experiences at home and in a variety of environments.

Communities across the country were invited to participate. Jan Morrison and TIES served as the part of the technical assistance team to the SFN. She urged Joe Merlino from 21PSTEM to apply on behalf of the Philadelphia region. Merlino solicited the participation of the STEAM steering group as well as Darren Spielman[76], executive Director of the Philadelphia Education Fund (PEF) and Lori Shorr,[77] the Chief Education Officer of Philadelphia Mayor Michael Nutter. A year previous, Mayor Nutter had launched his own STEM initiative called *STEMcityPHL* with PEF's support.[78] On July 31, 2015, in a spirit of collaboration, 21PSTEM and PEF applied for the small STEM Ecosystems grant as co-leaders for the Philadelphia region. On September 1, 2015 the Philadelphia region was selected to be one of 27 cities/regions to be part of the STEM Ecosystem Initiative.

8. The STEAM Design Studios 1-7

The significance for the STEAM Initiative of the Philadelphia STEM Ecosystem proposal development process and the subsequent award by the STEM Funders Network was the rapid creation of social capital for STEM and STEAM among the key partners in the city. This social capital formation would later be critical to gathering enough stakeholders needed to conduct the STEAM design studios. Hence, when it came time to launch the inaugural meeting of the first STEAM design studio on November 6, 2015, we were able to mobilize the Ecosystem partners to engage their networks of people to attend. As a result, a group of 122 individuals representing 70 Philadelphia area arts and cultural organizations; government agencies, school districts, universities and nonprofit education research groups came together to rethink urban high school education for the 21st Century.

In this first design studio, we asked participants to answer and discuss two foundational questions:

1) What are your aspirations for the way of life you would like to see for the Philadelphia region in the next ten years?
2) What does it mean to be an educated person at the end of high school?

The Inaugural Meeting of the Greater Philadelphia STEAM Initiative - November 6, 2015

Each participant received a questionnaire of six essay items to complete individually at their table. Facilitators at each table led the subsequent table discussions. The participants at each table were pre-assigned to a given table to maximize the diversity of the types of organizations. The duration was 2 ½ hours. All of the hand-written questionnaires were collected and later transcribed, typed and de-identified, and synthesized for common themes.

From mid-January to early February, 2016, six small group design studios were held with subsets of the November 6, 2015 participants as well as new participants. The goal of the small group design studios # 1 & 2 were to examine the questionnaire data and summarize the responses to each of the two foundational questions. 21PSTEM staff then composed a draft aspirational statement and aim of education. During design studios # 3 & 4, the questionnaire data was again reviewed along with the draft statements. During design studios # 5 & 6, the participants were asked to elaborate upon the meaning of the terms in the aim's statement. Each of the six design studios was 2 ½ hours in duration. They represented foundational Steps 1, 2 and 3 of the 18-Step curriculum design process. Below is the Aspirational Statement for the Greater Philadelphia Region by 2026 followed by the New Aim of Education for High School Students.

Aspirational Statement for Greater Philadelphia by 2026

We see a region that is diverse in many dimensions, yet united. It is a region with a vibrant economic and cultural life that offers equitable opportunities for all. Its people are engaged in collaborative civic, economic and cultural efforts to maintain a high quality of life.

We see a region with a thriving economy that supports meaningful employment, sustainability and a green infrastructure. It is a region that brings forth prosperity with policies that promote equitability of resources for everyone.

We see an education system that leads the way in teaching science, technology, engineering, arts and culture, and mathematics (STEAM), encouraging curiosity and promoting creativity while teaching 21st century skills. Schools, museums, businesses, and cultural centers work together to provide rich, interactive learning experiences for all ages. ALL public schools are well-funded and resourced with skilled teachers having access to and using current teaching materials in collaboration with the rich informal cultural and scientific educational assets of the region.

Every school student in the Greater Philadelphia region, regardless of race, gender, or socioeconomic status, has an opportunity to participate and thrive in its economic, civic and cultural life.

We see the Greater Philadelphia region as world-class, a place whose people revere the finer moments in their history, while possessing a critical understanding of it; yet who, at the same time, look forward toward a better future. It is a region with a culture of innovation that inspires and draws professionals from all over the world; a hub for STEAM education and careers. It is a place where people work together to achieve a sustainable future from the individual to the global levels.

A New Aim of Education for High School Students:

For high school graduates to discover their sense of place in a diverse and united community;

who are connected to the regional culture and the economy;

who can navigate the world around them and understand levels of complexity within their immediate community and beyond;

who possess a sense of purpose and resilience;

who can learn both independently and collaboratively with the capacity to think critically, solve problems, adapt, thrive, and create a sustainable life and world; and

who act responsibly and respectfully toward themselves and others.

9. The Meaning of Terms in the Statement of Aims

Once the aim of education was crafted, its key words and terms required further elaboration to expand their meaning (Step 3). This step would later be followed with an eighth design studio to outline the design principles for the STEAM curriculum development (Step 4). Together with the elaboration of the aim or core purpose to the STEAM high school, these design principles will provide guidance to expert teams to provide specific disciplinary and interdisciplinary content to fulfill the aim. (Step 5 & 6).

***Diversity** …to discover their sense of place in a **diverse** and united community.* We consider the meaning of *diversity* in its widest, most profound sense as encompassing the universe of differences. The natural world, including living things, manifests multitudinous variety. To be awake is to recognize and become conscious of such diversity.

Of all things existing and having existed, as a species, human beings present the most stupendous kind of diversity. Humans speak more than 6,900 different languages. We display a wide diversity of physical attributes, genetic makeups, health and medical status. People live in different locations and housing types and possess different socio-economic and marital status, levels of education, income, and types of employment.

People have diverse modes of self-expression, personalities, habits and dispositions. They have different types of dress, lifestyles and talents of all kinds. People have different modes and degrees of consciousness, cognitive abilities and ways of knowing. They have diverse points of views, opinions, ideologies and interpersonal relations; diverse life and work experiences.

Humans also have the unique ability to *create* differences through symbols and representations of thought and expressions. Thus the arts and humanities provide an almost limitless display of such human-made realities; virtual worlds constructed upon real ones, which themselves possess a kind of reality as art imitates life and life imitates art.

Extending beyond the individual person, the meaning of diversity encompasses family types, ethnicities, neighborhoods, religious communities, social organizations and associations of all types. There are a diversity of cultures, norms and values; traditions, such as food; group histories and forms of group recreation and entertainment.

We see diversity also as including economic and institutional dimensions. There are different types of industries that make up an economy, and various jobs and careers within them. There are a multitude of different types of businesses that offer a wide diversity of services and products that require various skills. In a community, there is a diversity of institutions from educational to medical to arts and cultural. There is a diversity of legal and governmental institutions and functions. Within each type of institutional category there is still yet more diversity.

All of the sciences recognize and reflect these manifold diversity of differences – biology, chemistry, geology, psychology to name a few. And within these broad categories, there are still finer subdivisions, such as Biochemistry, Biophysics, Molecular Biochemistry, Molecular Biology, Molecular Biophysics, Radiation Biology, etc.

All of these kinds of human diversities situate a person within a given community. It is from this widest concept of diversity that we intend students to discover their sense of place.

United*…to discover their sense of place in a diverse and* ***united*** *community;* While the physical world may possess an almost infinite number of apparent differences from the microscopic to the galactic, it is not random. Behind these appearances is an underlying natural order that is knowable. There are regularities that can be quantified in mathematical, geometrical and statistical terms. There is structure and pattern. Simplicity can be found. Three letters, for example, E = MC^2, symbolize the unity of all the mass and energy in the universe.

To gain insight into this order, this unity of the physical world as understood though science and mathematics, is to appreciate and delight in its elegance and power. As Johannes Kepler, the 16th century German Lutheran mathematician and astronomer saw it,

> **"**The diversity of the phenomena of nature is so great and the treasures hidden in the heavens so rich precisely in order that the human mind shall never be lacking in fresh enrichment."[79]

And when Kepler used mathematics to corroborate Copernicus's heliocentric theory of planetary motion that placed the sun at the center of the solar system with the planets, including Earth, revolving around it advanced nearly a century earlier, Kepler wrote,

> "I have attested it as true in my deepest soul and I contemplate its beauty with incredible and ravishing delight."[80]

Likewise, in the incredible diverse world of living things, we have grand unifying ideas such as evolution. At the same time, all things living consist of intricate levels of organization within themselves, where parts are combined and connected into a whole, which in turns becomes a part among others to form still larger wholes. Thus, we find molecules forming cells, and in turn forming tissues, which form organs and systems, which in turns form a living thing, with features and functions distinct from non-living matter. In turn all living things are united in their individuality as part of local ecosystems which together form our biosphere – the ecosystem of the globe integrating all living beings and their relationships.

Of all living things, human beings have unique powers to create new unities; to compose sounds and sights, technologies and processes into tangible processes and things. These created realities fold back on us to change our present lived reality and those of generations to follow, most readily evident in an array of technologies.

It has been said that with the advent of human beings, the universe became conscious of itself.[81] And so, when young people discover their sense of place in a **diverse** and **united** community, they become conscious of themselves and feel a sense of belongingness to the world because they are united to it as well as capable of creating new features of it.

Culture…*Who are connected to the regional* ***culture*** *and economy*

We regard the meaning of culture in two senses. In one sense, we regard culture as that which enhances human life through personal experiences and expressions. Culture in this sense refers to such things as sports, music, art, dance, plays, story-telling, festivals, restaurants, museums, parks, gardens, recreation centers, zoos, churches, universities, libraries, community-based activities and so on. There is a strong interconnectivity that exists through all these examples bringing people together to enrich lives.

In a second sense, culture also refers to the norms of behavior and commonly held beliefs, both conscious and unconscious, of a group. Culture in this sense reflects a group's values, norms and traditions. Groups have myths and stories wherein whose members tell and retell their aspirations and expectations, defeats and triumphs. It is the way the members of a group align themselves to each other as a collective.

Culture manifests in families, neighborhoods, and regions but its manifestation is not defined by geography. Whenever there are repeated associations of people a culture emerges. Thus, there are business and professional cultures; gang and street cultures; ethnic and religious cultures, and so on.

Economy…*Who are connected to the regional culture and* ***economy.*** By economy, we mean the Greater Philadelphia regional economy. The regional economy is more than the aggregate of businesses and industries. It includes all of the systems, such as banking and finance; legal and judicial; communications and transportation; and infrastructure, such as roads, bridges, harbors, energy grids and pipelines, water and sewerage plants that allow businesses to operate and people to work.

Every regional economy has "drivers" that provide a "value proposition" to the region and beyond. The Philadelphia economy's initial value proposition during the colonial era was that of a seaport. The seaport remains a regional economic driver today, but new economic drivers have arisen: ship building; advanced manufacturing; energy production and distribution; IT and communication technologies; biotechnology, pharmaceuticals and medical facilities; university research centers; finance and insurance, and so on.

A regional economy would not be possible, however, without human capital: the energies, talents and skills of its people. An economy works because every day people get up and go to work. Their work in turn is connected through intricate systems to other people's work, so that in concert the regional economy as a whole and those living within it can live and function. It is vital therefore that young people gain the skills, temperament and know-how to connect to the Greater Philadelphia regional economy to add value to others and in so doing to themselves.

Navigate… *who can* ***navigate*** *the world around them and understand levels of complexity*

There are several meanings to navigate. First, in a physical sense, it is about knowing how to move safely and efficiently around an area, city or region; how to do so between other cities and states; and even internationally. It includes such things as directions, locations, ticketing, schedules, purchasing and boarding, and so on. At a higher level, navigation is a science involving optimizing travel and trade routes, and use of technology such as radar, lasers, GPS and Landsat.

Then there is a kind of navigation that is more abstract. It is involves knowing how to gain information to know your way around for school, work, services, and resources; and how to ask questions and about processes and procedures, such as college admissions, loan financing, the legal system and finding employment.

We also regard navigation in a personal sense. Young people must be able to navigate within themselves, their emotions, desires, and struggles. They often face difficult choices amid peer and parental influences. They need an ability to navigate relationships along with discovering what they want to achieve and their connection to a greater community. Making smart decisions with credible information is part of what we mean by young people being able to navigate the world around them and find their place in it.

Complexity…*who can navigate the world around them and understand levels of* ***complexity.***

By complexity, we do not mean just something that is complicated or that which involves many steps or procedures, or where cause and effect is always apparent and in a straight line. Complexity rather involves novelties, emergent realities, feedback loops, bi-directional interactivity, co-dependencies and circuitous causal paths. For example, with human's ability to reconstruct the past and project the future, what we *think* will happen in the future can impact the present which in turn can affect the future. Likewise, how we interpret the past can influence the present which can in turn affect the future.

Complexity can most readily be seen in human relations, an area that novelists, artists, historians, psychologists and theologians have sought to illuminate. But complex systems can also be found in the natural sciences; in engineering and mathematics; and in business and economics. Urban settings have a density of complexity to them that can provide young people opportunities to develop complex modes of thinking.

Sustainable…*To create a* ***sustainable life*** *and world*

The ideas of sustainable life have several meanings. At the personal level, young people are particularly susceptible to death and injury from largely preventable causes. Indeed, more than 85% of the leading causes of death for people aged 15-24 are unintentional injuries (e.g., car accidents, overdoses), homicides, and suicides. Sustainable life on a personal level also includes notions of cultivating a good life, with healthy habits and behaviors. As the Roman philosopher Seneca wrote,

> It is not that we have a short time to live, but that we waste a lot of it. Life is long enough, and a sufficiently generous amount has been given to us for the highest achievements if it were all well invested. But when it is wasted in heedless luxury and spent on no good activity, we are forced at last by death's final constraint to realize that it has passed away before we knew it was passing. So it is: we are not given a short life but we make it short, and we are not ill-supplied but wasteful of it… Life is long if you know how to use it.

Sustainability at the regional level means environmental justice, where people are free from pollution, with access to health care and sources of healthy food. Sustainability also means economic justice: jobs with life sustaining wages, creating and operating businesses with an eye toward the longer term, and preserving and increasing responsible business practices so that the people and communities are not devastated by short term profit seeking.

In a still larger sense, because of our shrinking world where one group's actions can impact many people elsewhere and where the energy and natural resource consumption of billions of people can impact the biosphere itself, it is becoming necessary to consider what to means to have a life sustainable planet. As President Theodore Roosevelt warned a hundred years ago,

> "The conservation of natural resources is the fundamental problem. Unless we solve that problem it will avail us little to solve all others."[82]

Ultimately, the meaning of sustainability we want to impart to students is an attitude and a regard for the connectedness of generations. Young people not only have a responsibility to themselves for their sustainability, but an obligation to the rising generations behind them; to their younger brothers and sisters; and to those yet to be born. As the Great Law of the Five Nations of the Iroquois states,

> "Look and listen for the welfare of the whole people and have always in view not only the present but also the coming generations, even those whose faces are yet beneath the surface of the ground—the unborn of the future Nation"[83]

IV. The City as Classroom - STEAM Curriculum Framework

We have articulated a new aim or core purpose of high school in urban settings in the 21st century and elaborated upon the meaning of its terms. The next task is to develop the content of the curriculum. To do this task, guidelines or design principles for the content needed to be created. Accordingly, an eighth design studio was held at the 21PSTEM offices to establish the following curriculum design principles.

10. The Curriculum Design Principles

a. *Curriculum philosophy.* The philosophy behind the integrated STEAM curriculum framework is that a student's *entire* experience of the formal and informal environment constitutes the curriculum. This school experience includes: formal project-based coursework; informal learning in the city; Digital Fabrication Labs; STEM laboratories; the school culture and features of the learning spaces; and the various facets of school operations, e.g. schedules, lunch, break periods, transportation, dress code, etc.

b. *Learning Outcomes, (LOs)***.** The curriculum framework is composed of small sets of cleared defined Learning Outcomes (LOs) for each subject. LOs is subject content related to the aim or core purpose of the high school that require roughly 1- 2 weeks to learn.

c. *Standards***.** The Learning Outcomes must be benchmarked or cross indexed to the Pennsylvania State Curriculum Standards and all such standards must be accounted for.

d. *Sequence of Topics.* Learning Outcomes can be ordered and configured in light of the aim of the school so long as they remain conceptually coherent. For example, physics might begin in grade 9 with laser optics rather than in grade 12 with traditional mechanics.

e. *Learning Progressions*. Learning outcomes are ordered to be flexible so that students can construct their conceptual maps and discover their best paths on a learning progression journey that moves them from novice to expert.

f. *Integration of Learning Outcomes.* The National Research Council report, "*STEM Integration in K-12 Education*" emphasizes the importance of transfer of knowledge across disciplines, making connections explicit to students, and engaging in STEM practices like engineering design across subject areas. Therefore, all aspects of the school - from art, music, and the sciences, to the Capstones, to the Fab Lab experience of "making" materials, to the availability of extensive credit-bearing internships outside the school building – should be designed to support multi-disciplinary integration to the greatest extent that is practical.

g. *Organization of Learning Outcomes*: Learning outcomes are to be organized within a discipline to achieve conceptual coherence at the same time being integrated with other disciplinary learning outcomes to the maximum extent that is practical. To achieve maximum integration, there will be flexibility in the actual layout of the courses ex. biology every semester (not every day) and spaced learning outcome "threads."[84]

h. *Semester Capstones Projects.* Each semester will have capstone project based on the theme of the semester such that the project helps to integrate the various LOs.

i. *Curriculum Materials*. The curriculum materials chosen reflect the stages of adolescent interests and cognitive & emotional development, beginning with that which is most familiar to the student and working outwards to the unfamiliar.

j. *Problem-based*. The curriculum is problem-based beginning with the most fundamental problem that adolescents face: how to become themselves in a world of other diverse people in a way that leads toward the "responsible self"[85]

k. *Student electives.* The curriculum and assessment are intertwined to encourage the self-motivating learner who is both empowered and held accountable to themselves and others as part of a learning community. Thus the curriculum provides the students widening choices in content to be learned as students demonstrate their growing ability to seek out and evaluate information.

NEXT PHASE OF WORK TO BE DONE

11. Selecting Content to Fulfill the Purpose of the School

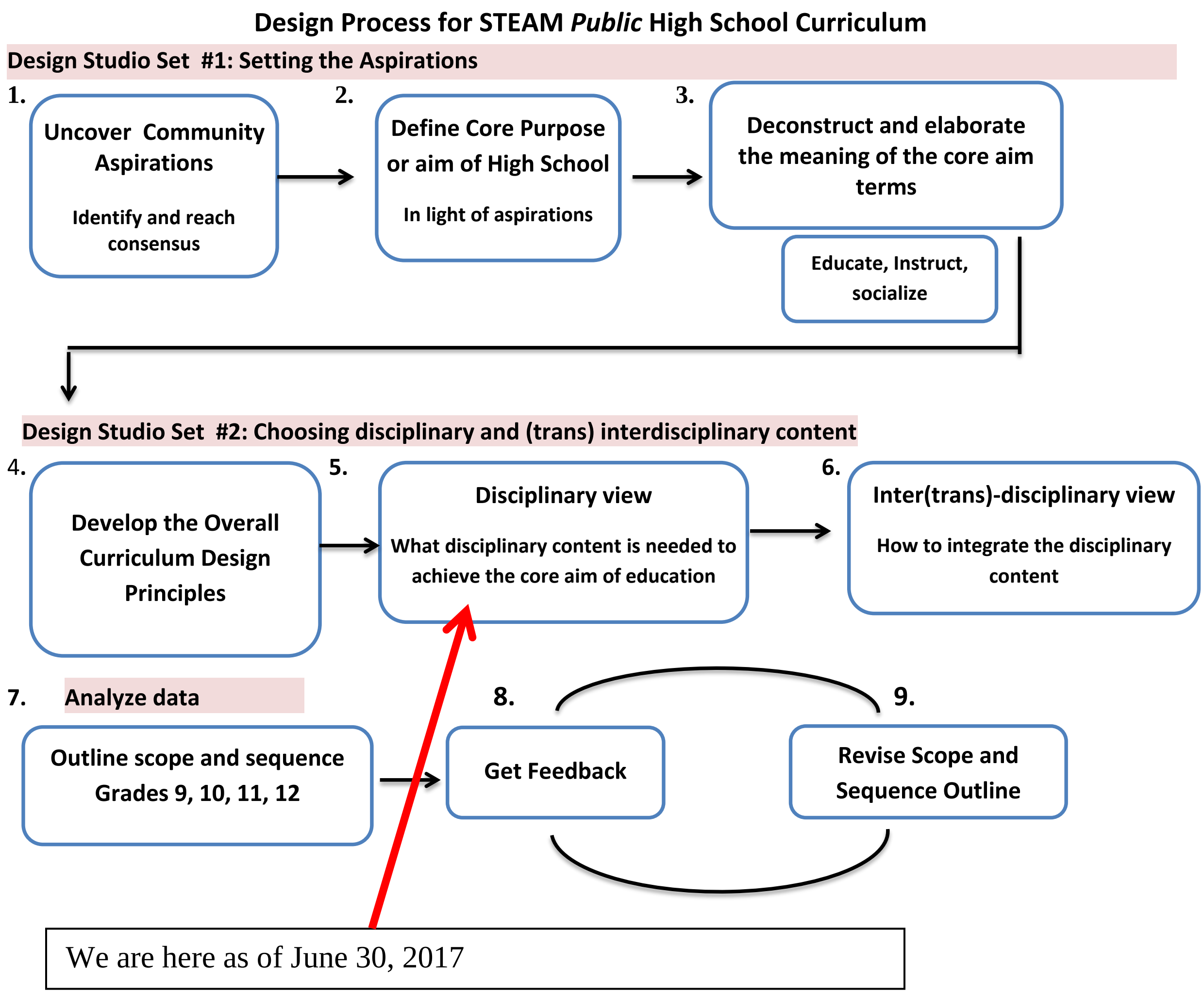
The next steps in the curriculum development process involves assembling content experts from various fields and subjects to select the content to fulfil the purpose or aim of the school as previously articulated. The content must be in line with the above guidelines. The content experts will include a cross section of subject matter teachers, university faculty, informal education specialists, researchers, and professionals in particular related occupational field. These disciplinary content design studies constitute Step 5 of the process. The following subject area design studio groups are anticipated to be convened. Possible sub-areas for discussion suggested as well.

- Mathematics - statistics, probability, game theory, risk assessment; geometric, algebraic, trigonometric and calculus applications; network analysis; Boolean algebra and computer coding;
- Biology – life and death processes; evolution and human development, ecosystems; diseases and their transmissions; brain and nervous system, genetics; biodiversity and medicines
- Chemistry – food, beverages, toxins, drugs, synthetics, industrial productions,
- Physics – acoustics, optics, kinetics, ballistics, electronics
- Social studies - cultural anthropology, world cultures, colonial and US histories of groups, migrations, slavery and servitude, pandemics,
- Art – compositions, mediums,
- Music - compositions,
- Literature – drama, theatre
- Kinesthetics - dance, sports, yoga
- Psychology – abnormal, addictions, aggression, family dynamics, child development
- Economics - capital, banking, labor, manufacturing, micro, insurance
- Systems – legal, financial, health, transportation; water, electrical, climate.

- Moral philosophies – MLK King, Gandi, Frederick Douglass, Torah, Gospels, Quran,

The interconnections between these sub-areas may have become readily apparent. For example, music, acoustics (physics) and trigonometric functions (math); diseases and their transmissions (biology), and social network analyses (cultural anthropology) and exponential functions (math); art, music and group histories (social studies); probability (math) and insurance (economics); neuro-toxins (bio-chemistry) and child development (psychology) to name a few. In Step 6, members from the above subject matter groups are mixed into interdisciplinary teams for another series of design studios to discuss these potential interconnections.

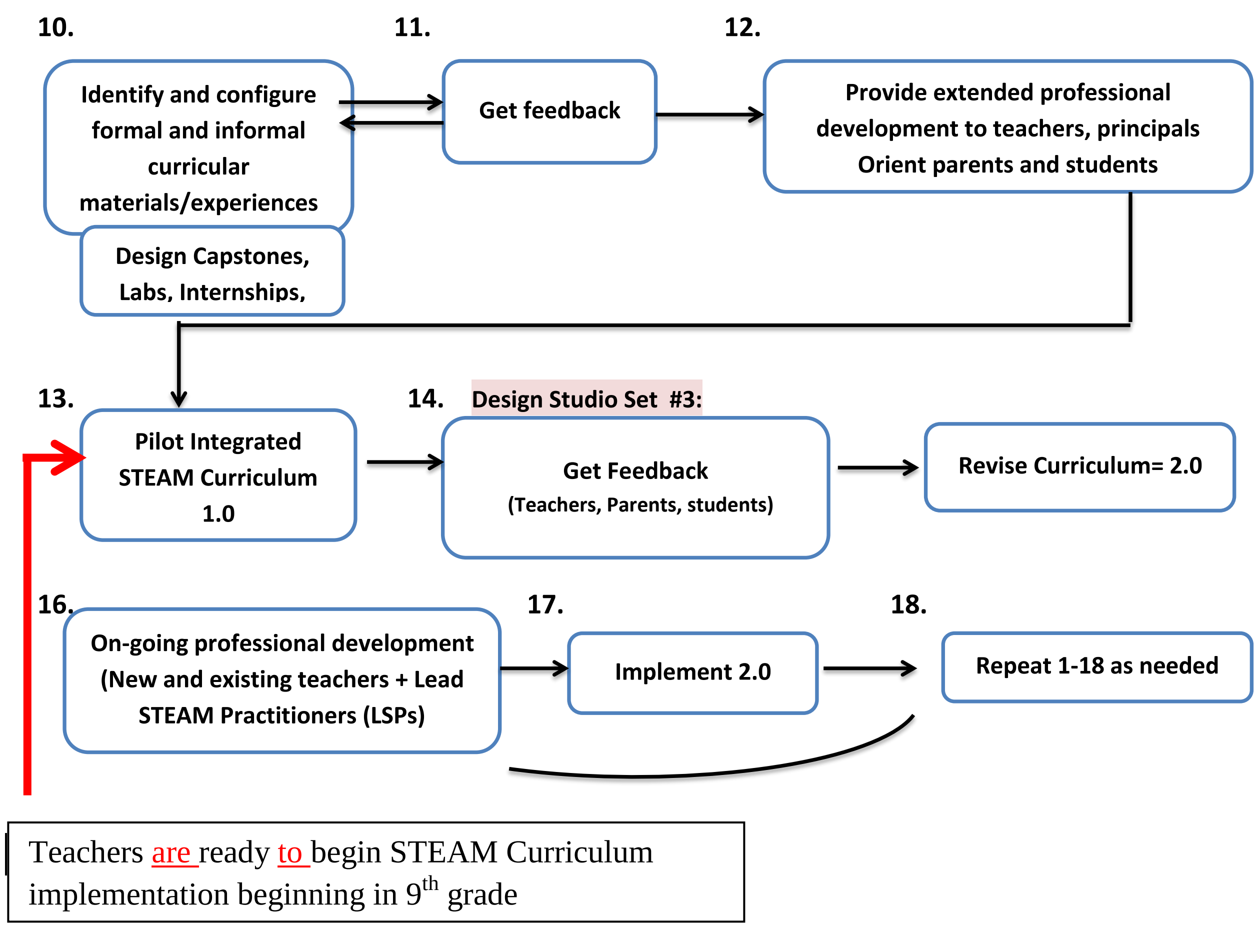
12. Summary of the Remaining Steps in the Curriculum Development Process



In Step 7, data is collected from the subject matter and interdisciplinary design studios, and woven into a mesh of topics that is overlaid across 12 semesters (3 semesters per year x four years) to create an integrated STEAM curriculum scope and sequence. In Step 8, feedback from key stakeholders (employers, secondary and post-secondary educators, parents, content matter experts and students) is obtained that will ensure the development of desired competencies and knowledge. In Step 9, revisions are then made to the curriculum.

In Step 10, teaching materials and informal education resources and learning spaces in the city are identified and cross matched to each learning outcomes. Capstone projects are created, along with the procurement of digital fabrication labs, science labs and other equipment. During this step partnership arrangements are negotiated with learning partners. To initiate this work and to uncover the voice of the community, we will expand upon the Philadelphia STEM asset survey already developed by the Office of the Mayor as part its *STEMcityPHL* initiative. This survey will be tailored toward key groups of stakeholders (e.g., business, higher education, K-12, non-profits) to enable a summary of key assets in the area, such as programs, instructional practices and tools, community centers, resources, funding opportunities, and key partners.

In Step 11, feedback is obtained from various stakeholder groups including prospective school teachers and principals. In Step 12, teachers undergo four weeks of professional development, where they write daily lesson plans for the first semester.in conjunction with informal educational providers. In Step 13, the school opens with its first 9th grade cohort and the enactment of the integrated STEAM curriculum begins.



In Steps 14-18 of the curriculum design process, experience with teaching the 1.0 version provides data for it subsequent revisions into a 2.0 version and beyond as more experience with the City as Classroom model is accumulated.

Below are two hypothetical stories of students from the City as Classroom STEAM high school.

1) For a ninth grade mathematics project, Meeka Robinson and a group of friends reported that 10% of young Philadelphia children had elevated levels of lead in their blood. Later, she prepared a social studies report on lead poisoning and discovered that the problem tended to be worse in areas where poor and minority children lived - places like her home in Central Philadelphia. Her team's tenth grade Capstone project measured lead in tap water, and found that half the apartments in Meeka's building had elevated lead levels. In eleventh grade, Meeka obtained an internship with the Philadelphia Water Department. That year, the city replaced pipes leading into Meeka's building and at several other locations Meeka identified. As a senior, Meeka won a Gates Millennium Scholarship, which she used to fund further studies in environmental science at Virginia Tech.

2) Bernard Small attended the City as Classroom STEAM high school because of his interest in drawing, even though he had struggled in math and science classes. In ninth grade, he joined a team of students that was using E-Line Media's Gamestar Mechanics platform to present ideas in algebra and physics. His graphical ability soon made him a sought-after partner for many math and science projects. He pursued his interest in graphic design in a for-credit after school internship with the Philadelphia Youth Media Collaborative - and by graduation, he was well on his way to becoming a professional graphic designer.

V. City as Classroom - Pedagogical Framework

The New Aim of Education also included these goals for high school students:

- to possess a sense of purpose and resilience;
- to learn both independently and collaboratively with the capacity to think critically, solve problems, adapt, thrive,
- to create a sustainable life and world; and to act responsibly and respectfully toward themselves and others.

These goals are accomplished largely in the manner by which students are engaged and motivated to want to learn; and how, when and where learning experiences occur so that optimal learning takes place. We consider all of this to be the school's pedagogical approach which is inseparable from the curriculum. The components of our pedagogical approach include: the art and science of teaching; the psychology of youth engagement and positive youth development; capstone projects; learning technologies; city as classroom learning spaces, school calendar and schedules, and assessments *for* learning.

The Art and Science of Teaching: The art of teaching lies in helping students to formulate questions that matter most to them and then to teach them methods so they can analyze and synthesize evidence. Thus, we interpret the phrase "personalized learning" in the sense that the curriculum has to be framed and presented in a way that has meaning and value to the student. We do not believe it is necessary, nor desirable, nor practical for a 9th grade student to invent a customized curriculum just for them or to come up with an idiosyncratic project idea from scratch. Young learners do not know as yet all of what they do not know. They are not as yet Ph.D. researchers. As fourteen and fifteen year olds, they need adult guidance. This is the purpose of the integrated STEAM curriculum – to introduce them to progressively more powerful concepts and experiences so that they can acquire insight into their world. What 9th grade student, for example, would spontaneously declare they wanted to know the probability concept of "expected value" that forms the mathematical basis of the largest industry in the world – insurance? How would they even know how to ask such a question?

We believe it is the job of the teacher to stimulate student thinking by asking purposeful questions that anticipate the forthcoming curricular content. Questions such as: What if? Why not? What do you think? The backbone for the organization of these questions is the City as Classroom's integrated, experientially-based STEAM curriculum that is back-mapped from the school's core purpose. It is in the fulfillment of this purpose through the curriculum together with artful teaching and collaborative learning that will allow for students to find personal meaning. The attached 3 minute video clip is illustrative of our approach. The clip is about Earl, a student at MC^2 STEM school, and his search and discovery of meaning.
HTTPS://WWW.YOUTUBE.COM/WATCH?V=ZS3IZD_B6DW

Teaching is also a science. Recent advances in cognitive science provide new insights on how adolescents learn. These advances are summarized in various publications from the National Academies of Science.[86] In addition, 21PSTEM directed a six-year Center for the Research and Development in Cognition and Science where cognitive science based techniques were infused into middle school science curriculum and studied for their effectiveness. Video presentations of the leading cognitive scientists are presented here. https://www.youtube.com/channel/UCqLPYjF0TnT872BGKu9vqUQ

13. The psychology of engagement, intrinsic motivation and positive youth development

A large body of psychological research known as "self- determination theory" has shown students' sense of autonomy; belongingness and competence are three critical factors to subject matter engagement and intrinsic motivation.[87] The City as Classroom STEAM High School is designed to promote these three factors. Two major features of our pedagogical framework are learning outcomes that are transparent and assessments that are formative, iterative and proficiency, or competency-based. The Young Women's Leadership Charter School in Chicago, for example, introduced a competency based assessment system that emphasized student agency. Each high school course was organized around a small number of learning outcomes. A student's report card described the number of learning outcomes mastered and reflected the student's best work to date. Students could return to learning outcomes from earlier in the year or even previous years, provide evidence that they had mastered the outcome, and receive full credit for doing so. YWLCS achieved the highest percentage of students going on to college of any non-selective public high school in Chicago.

Positive youth development (PYD) is a field and a strategy that embraces an asset (versus deficit) approach to working with children. (See **http://www.search-institute.org/content/40-developmental-assets-adolescents-ages-12-18)** One of the fundamental tenets of PYD is youth voice, choice, and empowerment, similar in many ways to self-determination theory. PYD encourages youth input, treats youth ideas with respect, and integrates youth perspective into activities, programs, and policies. Several Philadelphia agencies embrace this positive youth development approach. These agencies include:

- The Philadelphia Youth Network, which incorporates youth opinions into its programming and has a viable youth board;
- Temple University's Youth Voices takes a similar approach to cultivating youth input;
- Youth Adelphia, administered by the Philadelphia Foundation, cultivates youth entrepreneurship and philanthropy.

These agencies can assist the City as Classroom STEAM high school with advice on how to:

- Create an effective mechanism for eliciting youth voice and perspectives. This might include surveys, focus groups, and interviews.
- Prototype optimal physical and educational environments. Suggestions could include how to structure learning spaces that integrate both modern technology and materials for self-expression; and crafting lessons that combine teaching, learning, and mentoring.
- Engage community resources and partnerships that have proven effective with youth, and with addressing youth's preferences. These partnerships could include paid internships in local corporations, afterschool programs integrated into school-day curricula, and similar enrichment opportunities and convening strategies;

- Use quantitative and qualitative assessment tools effectively of youth development.

14. Capstones Projects

Capstones are semester-long, problem-based projects related to a social, STEM, and/or the Arts related problem. Capstone project themes are specified for each semester and serve to integrate learning outcomes across subjects. The theme or big idea comes from the integrated curriculum units for that semester. Capstone projects are designed to provide students with an authentic learning experience that prepares them for the challenges they will face in their future, all the while integrating the learning outcomes from their classes. As a result, capstones help to make schoolwork more relevant to students' lives by developing those kinds of problem-solving skills needed in the working world. Since companies often use project teams whose members have different talents, skills and cognitive abilities, it is important that students learn the value of and skills for successful teamwork.

In working on their Capstone project, it is expected that students will make use of Philadelphia's informal learning and cultural assets. External experts from universities, research centers and businesses can mentor student teams on their project, and, in so doing, provide windows onto possible careers pathways. For example, as part of a Gas and Oil Transportation Capstone, a team might test the concept of density and buoyancy by building different wooden and metal objects for floatation. They could then participate in a boat building class at the Independence Seaport Museum on the Delaware River, exploring model tankers and a real full-size submarine and cargo ship. Then they could go down the river to the Philadelphia Navy Yard to study with NavSea propulsion engineers. During the summer they may intern next door with Aker Shipyard, which builds large tankers.

Each semester, student teams select the problems they want to address within a given theme belonging to a particular semester. Each Capstone team follows a step-by-step Arts and Engineering Design Process (A-EDP) to solve a challenge. The A-EDP is a problem-solving template informed by the traditional engineering design process, along with Stanford's Design Thinking Process, and the Improvement Science work from the Carnegie Foundation for the Advancement of Teaching. Key steps in this process are: a) defining a problem/goal; b) reflective work leading to an initial try/prototype; c) measurement/testing/ feedback; and d) revision. The heart of A-EDP is the iterative learning processes built into each Capstone challenge. Student teams work through the steps of the A-EDP to ensure a disciplined and academically rigorous approach to their solution, (e.g., making a diagram, seeing closely, acting out a part, thinking ahead, etc.) The A-EDP helps establish a student culture of iterative learning and illustrates the value of formative assessment for learning.

Capstone summative assessments come from an authentic, professional poster conference setting where teams present their posters, tested prototypes and project portfolios which are evaluated by a panel of judges using standard rubrics. Capstones incorporate key Learning Outcomes from students' coursework, and in many cases students will be able to receive course credit by demonstrating Learning Outcome proficiency via their Capstone project. At the same time, individual accountability is assured by each student regularly submitting responses to their teacher's queries in the student's online journals. Using the A-EDP rubric, students' ability to transfer specific learning outcomes from other subjects into their Capstone topic is also tested.

MC^2 STEM High School Capstone video clip - 3:30 min
https://www.youtube.com/watch?v=JuXpZm2zzFo&index=4&list=PLsAEYIUOYzf2zt8D5soAOSg7GScyF0A02

15. Technology for Learning

Technology for learning involves different digital platforms that add value to learning *over and above* that which what can otherwise be done without it. Sometimes a pencil and eraser are sufficient. With this caveat, there is no question that technology, when properly used, opens up vast new possibilities for learning. For example, in the past to do research using primary source material would require trips to the library to laboriously locate and examine hard copy artifacts. But with the internet; search engines, such as Google; and digitized archived text and visual medium, it is now possible to search, locate and examine primary source material online at a fraction of the time it would take to do so by hand.

With the advent of high speed broadband connectivity, it is now possible to have high resolution, virtual face- to-face meetings with people all over the world. Also available online are visual media, live and asynchronous presentations, animations, and mathematical and scientific simulations and apps of all kind. Real time data feeds from multiple points around the globe allow students to conduct collaborative research projects with peers.

Productivity software such as word processing, relational databases and spreadsheets are now standard in classrooms. Less familiar is software for design and gaming simulation, such as Autocad Suite and Gamestar Mechanic. Visual and audio capture devices and editing software enable students to create multimedia communication products, from websites to short stories to documentaries. Digital arts technology is thus essential to a STEAM high school. Related to software is the ability to read and write code in various computer languages, a top in-demand skill with which students should possess basic literacy.

We must note here that technology systems are determined by the leadership, staff, and students in light of the school's educative purpose. Digital technologies can be a fantastic aid to learning, but they can also be terribly distracting. This is why a curriculum framework is needed, to provide guide rails to prevent unproductive, non-purposeful use of technology that winds up leading to aimless wandering, false pursuits and unlearning. The use of learning technologies, like any other technology, has two sides, and students will need to learn how to choose the side that leads to what is true and productive versus what is fraudulent and wasteful.

Digital Fabrication Labs (Fab Labs) and Maker Spaces add new dimensions to traditional high school science laboratories. Fab labs and Makers spaces represent the "E, in STEM (engineering). A Digital Fabrication Labs are a room with a collection of hands-on technology for students to turn their ideas of objects into reality. A standard Fab Lab includes: a Computer Numerical Control (CNC) router, which is a computer-controlled cutting machine related to the hand held router used for cutting various hard materials, such as wood, composites, aluminum, steel, plastics, and foams; a 3D desktop mill and scanner, vinyl and laser cutters; an electronics workbench; a 3D printer, and accompanying computers and software such as Gimp, Python, SketchUp Pro, Adobe, and Corel Draw.

Fab Lab goes beyond the 'kit' project to become a real resource for a personal expression. The Fab Lab will allow students to build almost anything, from making a team logo cut in a vinyl sticker material, to creating a mechatronic prototype with sensors, microcontrollers, Raspberry Pi computer processors and actuators. Students will have a real sense of ownership in their Fab Lab, using this important resource in Capstone projects to express their ideas first in the digital, and then the physical realm.

Many Capstone projects will employ the Fab Lab technology, providing students the opportunity to physically exercise the Design Process steps to design, build, and iterate. By doing so, students have a sense that they are addressing real problems that matter to them, such as clean water, energy, cyber security and transportation to name a few. Students will also use the Fab Lab for subject-specific projects such as art projects, physical models of mathematical relationships and tools for physics lab experiments. The Fab Lab can also be a place where cultural connections in the community can be expressed through problem-solving prototypes co-designed with the community or culturally relevant artistic expressions.

Teachers can find Fab Lab activities online from the global Fab Academy to support the learning outcomes, and will come to see the Fab Lab as a working laboratory for their classes, including arts and humanities. Fab Labs typically are noisy, energetic, community of students taking ownership of their work as they explore how formal learning, informal learning, cultural connections, and artistic expression intersect. Below is a short clip of Fab lab learning at MC2 STEM High School, Ohio.

https://www.youtube.com/watch?v=h5W9F_DagQk

16. Learning Spaces

The premise of the City as Classroom STEAM high school is that teaching and learning should not be confined to school buildings. Learning should be alive for students through active listening, questioning, and doing. To make learning come alive, as Dewey urged a century ago, a student must also have experiences that provide the grounded reference points for higher level abstractions. It is one thing to read about a submarine. It is quite another thing to physically be inside of one. In the 21st century, it is abundantly clear that the 20th century industrial model of a school as an efficient factory assembly line is obsolete, as Bill Gates opined. Knowledge and technology has explosion in depth and complexity. The President's Council of Advisors on Science and Technology (PCAST) report of 2012 emphasizes the great need for students to connect to real-world work and problems and for their studies to have a trajectory that is relevant and important to their communities and their own interests. This is reinforced in the National Academy of Science reports, *STEM Learning is Everywhere*[88] (Jay Labov) and *Integrated STEM Curriculum* (Margaret Honey). Our school aspires to this vision for our students and their engagement and for the staff as enabling this kind of learning.

We believe to confine learning to a single building is actually counter-productive, even mis-educative. In the 21st century, to the greatest extent possible, learning should take place both inside a designated "school" building and also beyond the school building to incorporate the rich assets of the city's informal education resources. The city becomes the campus. But can this really be done in Philadelphia?

For this Rethinking High School initiative, we have drawn inspiring examples from a number of STEM schools in the U.S. in which some of our team members have been deeply involved. Members from our team have designed and managed the award winning MC^2 *STEM High School* in Cleveland, which pioneered digital Fabrication Labs (Fab Labs) and semester capstones projects. MC^2 STEM High school classrooms are located in different learning spaces in Cleveland. Its 9th grade classrooms are located inside the Great Lakes science museum. Its 10th grade classes are located on General Electric research campus, where students regularly interact with GE scientists. Its 11th and 12 grades are located at the Health Careers Center and on various college campuses whose activities and staff are also incorporated into the life of the school. At any given time, you may see freshmen and sophomores immersed in workshops with tutors from NASA or in mentorship programs with engineers from GE Lighting, or juniors and seniors stepping up to demanding internships at a variety of local businesses. (See ttp://www.mc2stemhighschool.org). Other examples include Metro STEM High school in Columbus, where students take a course at a local hospital on how the body works co-taught by a biology teacher and medical staff; and at Science Leadership Academy (SLA) where students have lessons on science at the Franklin Institute Science Museum.

If STEM and STEAM learning are indeed everywhere, then the matter of "classroom space" becomes one of finding flexible spaces beyond the four walls of a classroom to where other types of meaningful teaching and learning can occur. The value of an informal city learning environment is determined by the degree to which it cannot be replicated within a traditional school space. Learning about seaports, for example, are best done on the cargo dock, or at a shipbuilding company, or at the Navy Yard, or at Aker Shipbuilders, or at the Independence

Seaport Museum where students tour ships and build boats. These examples are the kind of learning environments that we try to establish within our school community.

Our initial plan is for students to distribute their school time between a "home base," or a traditional school building; a series of "City Learning Labs," or local landmarks, resources, and organizations; and a "Fab Lab," or digital fabrication laboratory. The home base will give students a familiar starting point from which to begin their learning endeavors, while City Learning Labs will allow them to step into "expert" spaces and to take ownership of the city as their classroom. Finally, the Fab Lab will provide a space for communal, experimental, hands-on learning where students can undertake projects begun either at the home base or in learning labs. The goal is to afford students the opportunity experience real work settings.

At this stage in the Rethinking High School STEAM initiative, we do not know which informal city educational resources will be matched with the new school. The curriculum scope and sequence still has to be developed. Then, potential informal resources and Learning Lab spaces will need to be identified, followed by logistical, legal and financial considerations; and most importantly driven by their connection to facilitating implementation of the curriculum and achieving the aims of the school. We see the City as Classroom STEAM High School as a prototype, or first test case, to study to what extent informal assets can be successfully integrated with formal schooling, and to what extent such as arrangement can be replicated either in whole or in part with other Philadelphia area high schools. A new curriculum provides a best case scenario.

17. The School Calendar and Daily/Weekly Schedule

We envision a year around learning calendar for the City as Classroom STEAM High School. Students will be in "school" for four 10-week sessions with a three-week break between each session. This type of academic calendar has been successfully used by many STEM schools in the country for the past nine years, such as The Metro School, MC^2 STEM High School, Tech Valley High School, Manor High School and many more. This type of year round calendar is time-tested, providing well-spaced time periods needed for planning, resting, revitalizing and re-engaging with minimal loss of learning. If the City as Classroom STEAM High School begins in August, it will parallel the Philadelphia City Schools holiday vacation calendar. The three weeks off will offer students time to engage in internships and alternative, interest-driven learning, if desired. Staff will receive two weeks' vacation time; the third week will be a planning week to advance the capstone agenda, and engage in progress review of all students with professional support personnel, as is needed.

If students will be learning at both their "home" campus building and also using Learning Lab spaces at informal education institutions and other venues, then the construction of workable daily and weekly schedules is critical to the operation of the school. At this stage, we cannot provide detailed schedules. But there are some common considerations. For example, students will have a place and means of having breakfast and lunch. Dining together is preferred but not necessarily with the entire school at the same time. We see these times as part of the curriculum affording students not only sustenance for their physical well-being, but a means for their affective and social development well. We expect the morning classes to start around 9:30 am in keeping with the science about adolescent sleep rhythms. Classes most likely will be scheduled into blocks of 60-70 minutes, enabling sufficient time for project and technology enabled set-ups. The mornings will be time for students to engage in capstone projects with their design teams, faculty, and capstone advisors. At the end of this morning blocks, students will break for a lunch. They might go to afternoon classes, which might be in the same facility or might be located at another nearby location. Attached is a sample daily flex time schedule from MC^2 STEM high school

MC2 STEM High School uses time in a very unique way. Every Tuesday morning, we sit together as a team and decide what kids need what information and what information will be applied to what task. If it sounds confusing, it is, but it is with purpose that we do this. Nowhere in the real world does one enter in the morning assigned to work on math, so why should school work that way?

Every morning, we think of the project, we decide what needs to be accomplished, and we move ahead. Here are some sample schedules that we have used, but everything changes and nothing remains the same.

Schedule 1:

Monday									
		1st Period	2nd Period	3rd Period	LUNCH	4th Period	5th Period	6th Period	7th Period
		9:00- 9:54	9:54- 10:48	10:48-11:42	11:42-12:22	12:22- 1:16	1:16- 2:10	2:10- 3:04	3:04- 4:00
ENGLISH III	**338**	11A		11E		11D	11C	11B	Mastery
MATH III	**Floats**	11B (316)	11A (338)			11E (339)	11D (337)	11C (336)	Mastery
SCIENCE III	**339**	11C	11B	11A			11E	11D	Mastery
SOCIAL STUDIES III	**337**	11D	11C	11B		11A		11E	Mastery
ENGINEERING III	**336**	11E	11D	11C		11B	11A		Mastery
CHINESE	**316**		11E	11D	Lunch	11C	11B	11A	Mastery
ENGLISH IV	**317**	Mastery	12A			12D	12C	12B	Planning
MATH IV	**314**	Mastery	12B	12A			12D	12C	Planning
SCIENCE IV	**318**	Mastery	12C	12B		12A		12D	Planning
ENGINEERING IV	**313**	Mastery	12D	12C		12B	12A		Planning
GENIUS HOUR	**Floats**			12D (317)		12C (314)	12B (318)	12A (313)	

This schedule allows for "Genius Hour" which is work time the students use to complete their project tasks and develop their own. Time is unstructured and minimally monitored.

Schedule 2:

15-Dec-15	9:10- 11:10	10:20- 11:10	11:10- 12:00	12:00- 12:47	12:47- 1:34	1:34- 2:21	2:21- 3:08	3:08- 3:53
Social Studies	PT: TD	CSI		T48	CM		CC	TD
Engineering	PT: CC	TD		CSI	T48	CM		CC
Geometry		CC		TD	CSI	T48	CM	
Biology	PT: CM		Lunch	CC	TD	CSI	T48	CM
English	PT: T48	CM			CC	TD	CSI	T48
Mandarin	PT: CSI	T48		CM		CC	TD	CSI
Lori				Make Up Testing: English				
Notes for the day	During Project Time: Students will prepare for their presentations to the FBI Panel During Biology: Students groups will be sent down to the interrogation room for 10 minutes at a time to present their cases.							

18. Assessment for Learning

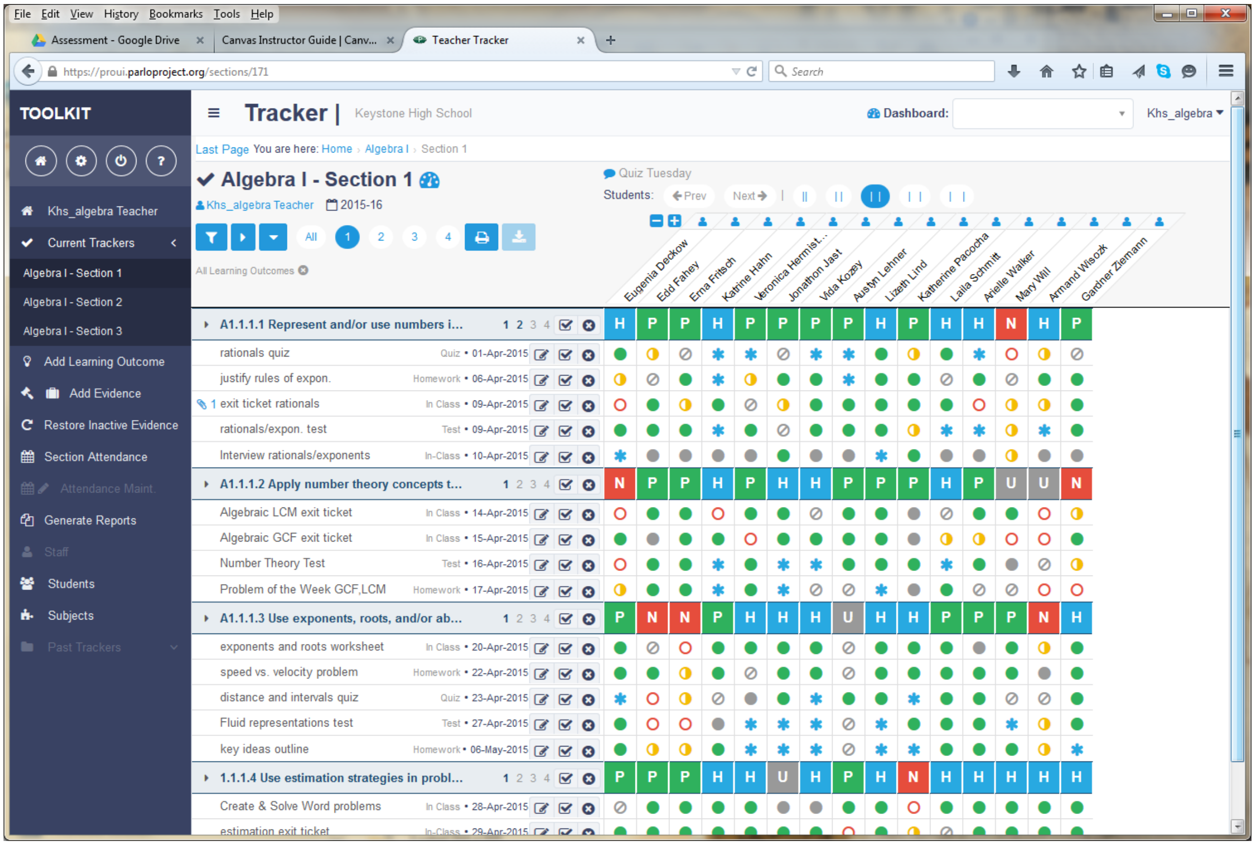
There are two kinds of assessments: summative and formative. Summative assessments are used to evaluate and certify the extent of a student's knowledge or performance at the conclusion of a learning period. Formative assessments are used during the learning process to provide corrective feedback to improve learning or performance. Research studies on formative assessment shows that the best kind feedback to improve learning or performance is written or oral comments about what is in error *and* what to do about it, but without "A to F" letter grading during the learning process.[89] Instead students who make early mistakes get full credit for responding to feedback and mastering the material. Formative assessment has also been found to promote a "growth mindset" in students, the idea that success and capability are malleable and can be improved through hard work with feedback.[90] In almost all fields, from engineering to sports, to the arts, initial failure is common, expected and a source of learning. Google has nine principles for innovation one of which is the belief "if you don't fail often enough, you're not trying hard enough."[91]

BREAKING THE CYCLE OF MISTRUST_WISE INTERVENTIONS TO PROVIDE CRITICAL FEEDBACK ACROSS THE RACIAL DIVIDE.PDF

https://www.apa.org/pubs/journals/releases/xge-a0033906.pdf

We will use two approaches to formatively assess student learning progress. The first approach is the Capstone ADEP rubrics discussed previously. The second approach is an assessment management system (AMS) of continually monitoring a student's progress toward achieving proficiency and/or high performance on each Learning Outcome. Courses will be 10-weeks in length. Each quarter, courses —whether learning takes place on-campus or off—will be contain approximately 2-5 Learning Outcomes. Proficiency on a Learning Outcome will be determined using various pieces of evidence, such as tests, quizzes, homework assignments, projects, etc. We will use Webb's Depth of Knowledge[92] as a framework to develop rubrics for ascertaining proficiency which will require students to apply what they learn. High performance will require evidence of student reasoning, planning, reflection, and creative adaptation. Over the course of the 10 weeks, teachers will assess student learning and provide feedback to students on their progress. Teachers will provide time, strategies, and materials so that students can use feedback to improve and additional opportunities to demonstrate their attainment of learning outcomes. Students will have opportunities to be re-assessed and obtain full credit for their work so that early failures are not held against them.[93] We expect early failures as they are central to learning.

A student's summative grade will be based on the number and degree to which each Learning Outcome is ultimately mastered and will reflect the student's best work to date at the end of the quarter. This may include the use of digital "badges"[94] and other mixed medium means for assessment. We call this formative assessment approach, "PARLO," Proficiency Based Assessment and Reassessment of Learning Outcomes. (PARLO) To manage various pieces of evidence in support of each student's progress toward proficiency for all of their learning outcomes, we will use an Assessment Management System software called PARLO Tracker, a web-based management tool that we developed over the past nine years with funding from the National Science Foundation and USAID-Egypt. The online log-in feature allows students, parents, teachers and administrations real time access to a student's learning status. The Tracker tool will be available at no additional charge to schools.



VI. Student and Teachers" Recruitment, Selection and Evaluation

19. Student Recruitment and Selection –

We plan to start 9th grade with about 100 students beginning in September, 2018. We anticipate growing enrollment one grade at a time rolling in 10th, 11th and 12th grades in successive years for a total school enrollment of 400 students. However, we anticipate students having elective courses to allow lateral and vertical flexibility so that a 9th grade student can potentially take a 12th grade course if they are advanced enough to handle the material.

Admission will be lottery-based. We will use the selection protocol and interview methods similar to Science Leadership Academy. The only admission criteria are that a student sincerely wants to fully participate in and be a responsible member of the school community. Given one of our school's core aims - understanding diversity in its many meanings – we hope to attract a student population that will reflect the full diversity of young people in Philadelphia under the age of 18. We hope to have a student body of different personality types, affective dispositions, aesthetic sensibilities, creative expressions, native languages, cognitive abilities, learning styles, family backgrounds, cultural roots and neighborhoods. We expect the school student body reflect the following categories:

83 % that would qualify for free or reduced school lunches

10 % English language learners

16 % special education

0 % disconnected youth (neither working nor in school prior to enrollment)

Race/ethnicity:

4 % Asian

11 % Hispanic or Latino

53 % Black or African American

22 % White

10 % Two or more races

20. Teacher Recruitment:

Hiring the best teachers can profoundly impact student learning.[95] However, teacher recruitment is typically "passive and provincial."[96] In contrast, we propose an active effort to attract and retain the highest quality teachers. We will draw from our collective experience of founding, staffing and leading innovative schools and from leading research on teacher recruitment in the highest achieving high poverty schools. We will prioritize recruiting existing teachers with experience in high poverty urban schools and others who have successfully completed non-traditional routes to teaching focused on urban education. We will actively seek teachers who reflect the diversity of the student body to the maximum feasible extent.

An important characteristic of high achieving, high poverty schools is a compelling organizational identity, a core purpose. Our school is driven by two key ideas: To use the Philadelphia region as a classroom to empower young people to discover their sense of place in a diverse community and to employ the engineering design process to empower both student learning and continuous school improvement. We will recruit applicants who are enthusiastically committed to both of these goals.

Equipped with this message of the school's mission for potential recruits and using selection criteria (see samples of published rubrics below) tied to our core purpose, our team will use multiple routes to locate high quality candidates. Formal approaches include the School District's human resources office, regional job fairs, and advertisements in relevant media. However, we believe that our informal contacts are likely to yield the most qualified teachers. We will seek recommendations from our extensive regional and national networks including university faculty, non-profit and informal education organizations, numerous partner organizations, and when identified, we will actively court these teachers. Like the best high poverty schools, we will also actively court successful completers of nontraditional routes to teaching focused on urban schools like Teach for America, but will require a three year commitment to the school.

Our team will also recruit informal educators to be members of our school-based team, drawing from Philadelphia's robust ecosystem of experts who provide exemplary instruction in museums, environmental education centers, out-of-school time programs, community centers, and other venues. Informal educators can provide content knowledge, STEAM-specific teaching techniques, and additional strategies such as classroom management and family engagement
RECRUITMENT RUBRIC.PDF
http://soe.unc.edu/academics/elem/evaluation_rubric.pdf

21. Teacher Hiring Process and Professional Learning Communities

An information-rich hiring process will help us recruit staff that fit the school culture, are impactful, and retainable.[97] We will use a tool developed by the Haberman Foundation to pre-screen teacher candidates called, "The Star Teacher Interview." This Questionnaire is made up of 50 questions each with three possible answers. This test is designed to evaluate a teacher candidate's knowledge and skills when it comes to teaching lower income students. The instrument boasts a 95% accuracy rate in predicting which teachers will stay and succeed and which ones will fail or quit. High success rates result from the ability of the scenario-based interview to give a clear picture of the candidate's beliefs about teaching at risk youth, and to predict how a candidate will behave on the job. Which ones will be able to handle the stress, discipline, unmotivated students and those who learn differently?[98]

Potential teachers will meet students and relevant stakeholders to see the school in action and thus inform their decision to join the community. Similar to traditional hiring processes, a team of teachers, students, school leaders, and community partners and members will review applicants' materials. Then they will conduct phone interviews, seek direct contact with references, and conduct in-person interviews. Candidate teachers will be observed during a demonstration lesson, followed by a post-lesson debriefing. Consistent with our commitment to the Arts-and-Engineering Design Process, we will select for teachers who are receptive to feedback and who want to grow professionally. Teachers selected in this way are more likely to have a positive impact at high-poverty schools.[99]

Every administrator and teacher will be a member of a Professional Learning Community (PLC) focused on improving student learning. We will implement supports needed to establish and sustain PLCs based on research[100] and our team's many years of experience designing and implementing PLCs. Supports will include: Carefully hiring teachers dedicated to improvement and group work; setting clear goals and expectations; consciously attending to building PLC group norms, providing supportive protocols, and building positive relationships. This will be bolstered by providing ongoing training for facilitators so that they can successfully blend structure with participation and can lead teams in the systematic use of data focused on improving student learning[101] Additionally, we will ensure dedicated weekly time for PLC members to plan together: Identify PLC members' needs through an initial needs assessment and ongoing surveys and focus groups; provide content and skill development activities as identified by the needs assessments; engage in ongoing evaluation of PLC effectiveness through surveys, focus groups, and observations.

Professional Learning Communities (PLCs) comprised of teachers and administrators will use the SPR, their experiences, and locally generated data to identify problems and opportunities so that we can define issues to resolve during the coming year. PLCs will use detailed student-level data to identify who is having difficulty and diagnose the reason why. The PLC team will then develop a prototype "theory-of action" for improvement. Staff will use an ongoing rapid cycle improvement process, creating short-term, intervention-specific measures (observational checklists, short student surveys or interviews, common assessments used by multiple teachers, etc.) to test whether prototype change ideas are having their intended immediate effects. Based on results, PLCs will revise and re-test change ideas. Facilitators will keep PLC work focused on student learning, practical data collection and continual design-based improvement.[102]
TEACHER RUBRIC.PDF http://www.dpi.state.nc.us/effectiveness-model/ncees/

22. Teacher and School Evaluation

We will use a simplified version of a number of Teacher Evaluation frameworks compiled by Dr. Gary Cooper as part of the Egypt STEM school project. However, research shows that how a framework is used matters more than which specific framework is chosen[103] Feedback needs to be frequent, to include clear goals and data to support claims about a teacher's progress, to monitor ongoing progress, and to focus on formative, not summative, evaluation. Building a relationship of trust is critical to an effective feedback process. To ensure that feedback from administrators and peers is frequent, data-based, and supportive our evaluation process will be based on the attached Feedback Process Map and Teacher Feedback Protocol. Please see the three attachments for details.

PROCESS MAP FOR OBSERVATION AND FEEDBACK_EXCERPTED FROM PARK,TAKAHASHI,WHITE,2014.PDF

http://cdn.carnegiefoundation.org/wp-content/uploads/2013/08/CF_Feedback_90DC_2014.pdf

PROTOCOLS FOR OBSERVATION FEEDBACK_MYUNG AND MARTINEZ,2013.PDF
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PHILLYRUBRICDOCV0102.PDF
http://webgui.phila.k12.pa.us/uploads/q9/Ti/q9Ti4ty65NfIkPMdeIds5Q/PhillyRubricDocv0102.pdf

The School District of Philadelphia School Progress Report (SPR) reports school effectiveness in the areas of Achievement (percent Passing and Advanced on key tests), Progress (achievement growth), Climate (including attendance, discipline referrals, survey measures), and College and Career Readiness (graduation rate; AP/IB and SAT/ACT performance, FAFSA completion rate, college enrollment). The SPR will be the starting point for our school-wide evaluation process.

VII. Governance, Management, Partnerships and Finance

23. Governance –

We have chosen to initially attempt to become a new model school within the School District of Philadelphia administrative structure, as opposed to a public charter school or private school, for three reasons: 1) if successful, we want the *City as Classroom STEAM High School* to be a transformational model for as many underachieving public high schools as possible; 2) we believe a district school may be more acceptable to our informal education partners, and 3) given the establishment of the Office of New School Models (ONSM), we believe that a SDP district model school may be more readily established than a charter school and with greater chances of sustainability.

As a new Model school operating within the School District of Philadelphia administrative, *City as Classroom STEAM High School* would be overseen by an assistant superintendent who leads a regional network of schools. According to the Office of New School Models each redesigned Model school is assigned an assistant superintendent, but the school will otherwise have flexibility over its management. A memorandum of understanding (MOU) can be written between the SDP and the Model school as it pertains to its governance.

With respect to the *City as Classroom STEAM High School's* relationship with the Philadelphia Federation of Teachers (PFT), the School District of Philadelphia's (SDP's) Collective Bargaining Agreement (CBA) with the PFT stipulates that the district, "possesses the right, in accordance with applicable laws, to manage all operations, including but not limited to the direction of the work force and the right to plan, direct and control the operations of all schools, equipment and other property…[including] discretion as the right to hire, to determine the size of the work force, the use of schools…"]

As per the CBA above and precedent for MOUs set with Science Leadership Academy (SLA) established 10 years and more recently with several more recently established district model schools supported by Carnegie, we, too, will seek an MOU with the SDP. This MOU will seek to include flexibility as regards to site-based selection of teachers, the use of informal education staff, budgets, contracts for instruction service, curriculum and instruction, calendars and schedules.

The *City as Classroom STEAM High School*'s status as a Model high school follow the protocols established by the Office of New School Models (ONSM) within the SDP. In 2013, the SDP became one of four districts nationwide to receive a Carnegie Corporation of New York's Opportunity by Design Challenge award. This grant provided funding and technical assistance to support new school design efforts for two new public Model High Schools in Philadelphia. Also a new Office of New School Models (ONSM) within the SDP was established to nurture more new school models. In addition, a parallel effort called the School Redesign Initiative (SRI) was initiated which seeks to redesign existing schools using the same Carnegie design principles. This new Office of New School Models is part of Superintendent William Hite's Action Plan 3.0.

SCHOOL_REDESIGN_INITIATIVE_APPLICATION_-_FINAL_PDF.PDF
http://www.schoolredesignphiladelphia.org/uploads/2/6/6/4/26641146/school_redesign_initiative_application_-_final_pdf.pdf

24. Management -

Once the curriculum framework is completed, there will be a myriad of facility, procurement, logistical, scheduling, hiring and budgeting issues that will need to be resolved. TIES has created a propriety School Design Blueprint for establishing STEM schools to help guide this process and we will use it here. The School Design Blueprint will provide management guidance for the team, while allowing flexibility in processes and protocols to achieve the intended goals. Many problems can be avoided with careful planning and the employment of processes for conflict resolution. To manage these issues, we will collaborate with the SDP, key informal education partners and community stakeholders. Honoring differing points of view, within a school culture of active listening and respect for evidence, is important to bringing about practical solutions to the above issues.

We expect there will inevitability arise many implementation problems in this unique new school. We see these challenges as learning opportunities for us and the wider education community. We also expect that there will be many mid-year course corrections as we learn of new issues and opportunities. To handle potential issues, we will: 1) have regular leadership calls with our informal partners and, 2) convene periodic strategy sessions with the regional education community advisory group to help probe issues and understand the root causes, identify potential solutions, and implement a corrective action plan. All potential solutions will be prioritized to focus on the design principles for the school. Finally, if we find that expectations do not match reality, we will discuss possible changes with the district and re-negotiate agreements with our informal education partners as needed to get as close to the intended goals as possible.

In terms of school operations, prior to the beginning of each new academic year, the school leadership team will create an Annual Implementation Plan (AIP) to guide the work during of the coming year in collaboration with teachers and partners. Years 1-4 of the *City as Classroom STEAM High School* it will be especially critical. The entire team will need to remain faithful to the curriculum and school design principles to ensure the integrity of the model. In our experience, while many issues may arise, coming back to these principles will help guide decision-making so that policies and practices are consistent and coherent. The core strengths of our school team are our varied backgrounds and perspectives. Our team includes former superintendents and numerous principals who have managed districts and school budgets. We also have other project staff members who are well versed in managing large grants. We plan to employ a school operations manager to make sure processes are followed and timelines and obligations are met.

The *City as Classroom STEAM High School* will have three implementation phases and milestones within each phase:

1. <u>Development -</u> This phase will include all activities to ready the school for opening in Year 1 of the project. Activities will include:

a) Developing capstones and the curriculum (steps 4-13 of curriculum design process), which will include previous participants from earlier design work as well as prospective students, teachers, and principals for the new school as well as other academics;

b) Defining key assets and possible partners for the informal learning labs;

c) Customizing the School Design Blueprint;

d) Recruiting and hiring staff;

e) Conducting teacher professional development

f) Recruiting, selecting and enrolling students;

g) Obtaining and/or retrofitting a new school space;

h) Procuring labs and education technology;

i) Contracting services to support the school (such as food services).

A series of school operations design studios will be conducted with key stakeholders representing the district, schools, museums, business community, early education institutes, PK-12 schools, and community members. The outcome of the Development Year will be an implementation-ready Design Blueprint, an actionable document defining all the assets and recommendations for the implementation of *City as Classroom STEAM High School* to ensure a robust launch and long-term sustainability. The Blueprint elements will be vetted in conjunction with the SDP. The Design Blueprint serves as the roadmap against which the project implementation will be evaluated. It will contain: STEAM design features, success indicators for short and long-term implementation, and action items, resources, and roles.

During the Development Year the school team will also create a plan to mitigate risks associated with the readiness of the school to open doors on time. The risk management plan will be critical to identify both the severity and likelihood of the risks. With the risks identified, the team can develop appropriate mitigations and work to circumvent potential issues. However, unknown risks can arise at any time and we expect that to occur.

2. Implementation and Refinement - This phase will include all tasks and associated activities to open and operate the schools in Years 1-4. These tasks pertain to:

a) Annual school openings;

b) On-going site support and lesson planning;

c) On-going professional development;

d) Semester capstone exhibitions;

e) Capstone refinement;

f) Curriculum assessment and refinement;

g) Piloting of new innovations;

h) Assessments of school and student work.

3. Documentation and Replication - Documentation of the school successes and challenges will be on-going, but will culminate in Year 4. To support replication in other schools throughout the region and even country, a number of multi-media resources will be developed. Activities will include: a) the creation of a *City as Classroom STEAM High School* manual, with connections back to a refined and codified Design Blueprint for school replication; b) outreach, tours, and dialogues to spread the school success, c) invited academic researchers to study the school. It is the intent of this Model school to be a platform for the Philadelphia School District so that it can find opportunities and build on networks and programs we help to establish.

Each of these phases will be refined throughout the project, but the initial year and high level milestones for subsequent years have been determined and included in a Gantt chart. The milestones and tasks will be refined annually as part of a planning process to re-align the team toward our overarching goals and objectives.

25. Partnerships

City as Classroom STEAM High School's very design is based on partnerships between formal and informal learning spaces as evidenced by the broad spectrum of its participating organizations. Representatives from over 70 informal arts cultural, historic and scientific education organizations have participated in the *City as Classroom* initial design studios. These informal education organizations collectively interact daily with thousands of young people.

The breadth of our informal education partners and their commitment to rethinking high schools in the twenty first century makes the vision of the city as a classroom a realistic possibility. Future sessions during the Development year will establish more permanent relationships between stakeholders to ensure the project's support and sustainability. Session outcomes will highlight key opportunities for engagement by community members.

City as Classroom STEAM High School will seek to establish more formal partnerships with 2- and 4-year colleges to provide college courses, outreach and research opportunities, and information about college access and financial aid. Student internships with local business, research and medical centers and government agencies will be important learning opportunities. Local industry certifications, as well as online IT certifications, such as Udacity, will be also sought. In turn, STEAM related business and industry as well as the arts and cultural community will benefit from the great students that will graduate from our school. Therefore, we will seek to develop extensive regional networks of schools and learning sites.

As is the case with other Model schools in the SDP, we will have an advisory committee composed of formal and informal stakeholders, higher education partners, business and government leaders, and student and parent representatives. *City as Classroom STEAM High School* will invite as advisory committee members representatives from the following organizations that have been instrumental to the development of this proposed new vision of high schools in urban settings:

- *The Greater Philadelphia Cultural Alliance (GPCA)* comprised of over 400 members encompassing arts, cultural, historical and scientific organizations. https://www.philaculture.org/
Groundswell Video HD.mp4 https://www.youtube.com/watch?v=dy386UomXPk
- *The University City Science Center* which supports entrepreneurship and technology development in the Greater Philadelphia region through 31 nonprofit shareholders including many local distinguished colleges, universities, hospitals, and research institutions. See the attached video. https://www.youtube.com/watch?v=eUBw4clYUis
- *STEMcityPHL*, a civic campaign to build collective public will for excellent STEM education and opportunities, ensuring that all Philadelphians can participate in the economy of today and tomorrow. Launched by the Mayor's Office of Education in partnership with the Philadelphia Education Fund, other local nonprofits and local businesses including Saint-Gobain, GlaxoSmithKline and IBM with a focus on increasing access to STEM careers for girls, underrepresented minorities, and low-income children. http://www.stemcityphl.org/
- *The Philadelphia STEM Learning Ecosystem*, a collaborative endeavor of key institutional stakeholders led by the Philadelphia Education Fund and the 21st Century Partnership for STEM Education will provide the "connective tissue" between the informal and formal learning centers of the school.
- *Workforce and Industrial Development,* such as the Economy League, Select Greate, DVIRC, PDIC, the Navy Yard. Their role will be to provide ongoing curricula review and informal educational experiences for students such that they are aligned to current and projected regional workforce needs

We also plan to have a *"Friends of the City as Classroom STEAM High School"* to raise funds to support student-led entrepreneurial projects and a study of the school's longer term influence on our graduates.

All informal and/or higher education or business partners involved in providing services and/or learning spaces will sign an agreement confirming their scope of work, deliverables, milestones, and schedule. Further, the school team will meet regularly with the partners to discuss the student progress and any implementation issues. These meetings will be used to elevate any immediate concerns or potential impacts on the performance/schedule/budget so that corrective actions can be discussed and implemented.

26. Finances

Current school finance situation in Philadelphia: As of April 21, 2016, The School District of Philadelphia anticipates revenues of $2.805 billion and operating expenditures of $2.794 billion, resulting in a slight projected operating surplus of $10.8 million.

LUMP-SUM-PRESENTATION_3.24.16.PDF
http://webgui.phila.k12.pa.us/uploads/7e/G7/7eG78xle4GC4O5xQnJElxg/Lump-Sum-Presentation_3.24.16.pdf

The total on-going cost of implementing our school model after a five-year phase-in period is based on a comparably sized school, Science Leadership Academy (SLA) that has a close relationship with an informal education partner - The Franklin Institute. SLA has been established for 10 years so it provides a good basis for a projection as to the on-going cost of our model. There are three means by which we constructed a cost estimate to staff and operate a school for 400 students: 1) the SDP publishes the District Operating Budget that gives each school's budget allocations in terms of positions; 2) a second publication is the Guide to School Budgets that outlines the cost of each position and provides a budget range for different sizes of schools; and 3) a third source is the SDP Employee Salaries.

SDP 2016-17-GUIDE-TO-SCHOOL-BUDGETS.PDF
http://webgui.phila.k12.pa.us/uploads/KR/ga/KRgab7qrkysG6U3_-mfIEQ/2016-17-Guide-to-School-Budgets.pdf

School Financial Autonomy: The SDP has granted principals the autonomy to reallocate their basic operating dollar amounts for purposes in order to provide educators with the ability to adapt resources to meet students' needs with the exception of enrollment driven teachers. As such, we anticipate that a certain portion of the *City as Classroom STEAM High School's* budget will go for a coordinator of public- private partners and for contracted services to informal education partners' learning spaces and educators.

Available local, state and federal funding streams: The pupil allocations from the SDP will provide a basic level of funding during the first five year period and beyond. Other funding streams include federal Title 1 and Title 2 formula grants.

Capital Expenses: For the startup of a new school buildings, under Pennsylvania law the following items may be charged to a capital fund: Textbooks, Library books, Courses of study, Instructional Aids, Educational Software, Furniture & Furnishing, Office Equipment, Educational Equipment, Maintenance Equipment, School Computer Equipment, Admin Computer Equipment, Cafeteria Equipment.

CAPITAL-GUIDELINES--UPDATE-112808.PDF
http://webgui.phila.k12.pa.us/uploads/qg/Lr/qgLrr4J3LVxhjfQMHYCmew/Capital-Guidelines--update-112808.pdf

Overall School Budget: We project the SDP contributing about $9 million over 5 years not including capital costs. It is expected that the district will cover other standard costs, such as student transportation, meals, and building services. Meals are the same as any other SDP school - roughly $2.50 per student for food. Regarding transportation, the SDP issues a bus/subway pass for each student.

We are mindful that the operating costs for *City as Classroom STEAM High School* must be such that it is feasible for the SDP and other similar urban centers to replicate and scale the model within their budgetary constraints. For this reason, it is important that products such as the curriculum and capstones can be taken “off the shelf” and readily adapted by others.

Methods of garnering additional resources: Based on the enthusiastic reception of our informal education partners in arts, culture history and science, they are eager to be involved with our STEAM school. Without a *City as Classroom STEAM* type of high school it is difficult for the informal education community to play an ongoing and robust role in formal schooling. Our school is specifically designed to overcome that problem. We believe the philanthropic sector likewise would be eager to support the school. On the corporate foundation side, one of the goals is to develop an economic value proposition for local corporate support as well as tax-supported replication at other sites.

VIII. Future Tasks and Funding Needs

Our current need is to obtain funding from federal, state or local government, and/or corporate and private foundation grants, to support the continued development of the *City as Classroom STEAM High School* model. Development funds will be for the following tasks:

1) The first task is to conduct a series of inclusive design studios to develop the STEAM curriculum framework, scope and sequence, learning outcomes and capstone projects that is back-mapped from the school’s core purpose. This process will require about six months and is estimated to cost about $250,000.
2) The second task is to work with our partners to match informal and formal assets and materials to the learning outcomes and negotiate MOUs. This process will require about three months and is estimated to cost about $ 125,000.
3) The third task will be to obtain school spaces and address any retrofitting needs in the school building, such as upgraded IT infrastructure. This also encompasses procurement of labs and equipment, such as Fab labs, IT equipment and student texts and recourse materials. These are capital expenses.
4) The fourth task is to recruit and hire teachers and provide professional development of the new teachers, as well as; support the teachers as they prepare to open the school. We estimate the time to complete these steps to be about 3 months with a cost of about $ 75,000.
5) The fifth task will be to recruit, interview and enroll the students.

The use of additional grant money during Years 1-4 of the school would be to revise and iterate the curriculum framework, learning outcomes, capstones, learning space venues and activities for informal learning based on teacher, student and partner feedback. This process would be done for each year as the grades were rolled out. Other funds would be used for an independent formative evaluation of the school's operations, management, and budget to continuous improve the model.

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